POWER

A McGRAW-HILL PUBLICATION—ESTABLISHED 1884

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Volume 70 NEW YORK, JULY 16, 1929 *Number 3*

Smoke Prevention

A SMOKING mill chimney looks good to a town that has been through hard times and the suspension or closing down of its principal industry. The waving pennant of soot betokens employment, income and the return of prosperity.

It may pollute the atmosphere and begrime the surroundings; but it brings clean money.

True. But it is a costly nuisance and not at all a necessary concomitant of industrial activity.

Notwithstanding all that has been said and written upon the subject, the evils produced by atmospheric pollution in cities where large amounts of fuel are burned are inadequately appreciated.

In addition to the defacement of buildings, the soiling of furnishings and wearing apparel and goods in stock and store there is the irritation of the respiratory organs and the more subtle effect of the screening off of the actinic rays, which health authorities have recently found to be so serious.

Happily modern methods have made it possible to burn most fuels without objectionable smoke, and the progressive manager of an industrial establishment will realize that in many ways it will be to his advantage to run with clean chimneys and avoid being a nuisance to the neighborhood.

When one is slow about recognizing this the authorities should insist upon suppression, not—except in the case of obdurate offenders—with a policeman's club but with expert advice and direction.

Usually conditions can be improved sufficiently without onerous restrictions, excessive expenditure, or interference with production.

Most managers and operators would like to be good in this respect if they knew how.

F. R. Low

POWER *Stands for . . .*

1. **Making Power When It Should Be Made**
2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**

One Code Instead of Two

IN THE March 12 number of *Power* an editorial was published that deplored the number of boiler-testing codes that had been adopted by various societies. At that time the American Society of Heating and Ventilating Engineers and the National Boiler and Radiator Manufacturers Association had each adopted different codes for testing steam-heating solid-fuel boilers.

It is gratifying that the A. S. H. and V. E. at its Summer meeting, a report of which was given last week, adopted the code of the National Boiler and Radiator Manufacturers Association as its standard performance test code for steam solid-fuel boilers. By this action it has prevented the confusion that would have resulted from the existence of two different codes for testing similar equipment. The society is to be complimented for the promptness of its action.

The testing code that was adopted at the heating societies January meeting has been revised. It is now a short form heat-balance code for testing low-pressure steam-heating solid-fuel boilers. Thus the work of preparing the original test code has not been wasted.

Contingency Factors in Heat-Balance Calculations

VARIOUS methods have been presented whereby it is possible with known data on main turbo-generator, boiler and auxiliary performances to find the probable heat consumption of a proposed plant under varying load conditions. These calculations are generally based on assumed constant steam pressure, temperature and vacuum, together with given boiler efficiencies at various ratings. The results of such calculations have been found by experience to be reliable and to correlate with actual performance under operating conditions.

But in station operation there are certain contingencies that arise that cannot well be covered in such calculations. Superheat may drop because of dirty superheater tubes. Boiler efficiencies are occasionally low due to poor air-fuel mixtures. The absolute pressure in the condenser may rise because of foul condenser tubes. Turbines must be warmed up and brought up to speed slowly, thereby using non-productive steam in the meantime. To allow for such variations from calculated performance, a factor known as the "contingency factor" has been applied in some cases to the theoretical heat-balance calculations.

Little has been said about the contingency factor. Its need is apparent and its importance will be recognized, for it covers the variables that appear even in the operation of the best stations. After a plant is built, its actual performance may be compared with its theoretical heat balance for the given operating conditions. In general, the actual performance will exceed the calculated performance by this ratio, which has been called the contingency factor.

Few data are available on modern stations to indicate the exact value of this factor. It is obvious that plant designers could work to better advantage if more were known about its values. Does it amount to 10 per cent or is 3 per cent more nearly its usual amount? An inquiry into this subject by one of the committees of our national societies would repay the effort.

Further knowledge of the real values of contingency factors would serve to direct the attention of plant designers and operators to certain of those sources of heat demand that do not produce any useful output. A study of these demands would undoubtedly lead to many improvements, which would be reflected in better station performance. Let us have some actual data on contingency factors.

Why Reserve Strength?

LACK of knowledge on which to base an intelligent decision frequently requires making the factor of ignorance high, in order to be on the safe side. An outstanding example of this is in condemning wire rope. It is generally admitted that the majority of elevator ropes are condemned and replaced when they still have considerable safe life remaining in them. To obtain more of the useful life of these ropes without jeopardizing the safety of the equipment has been the subject of much discussion. It is generally considered good maintenance practice to replace worn machine parts before they reach a condition that would hazard the reliability of the equipment. Rather than wait for something to happen to cause a shutdown, periodic overhauling to insure continuous operation is looked upon as sound economic practice. Therefore, if errors on the safe side are made when replacing wire rope, it is a practice that is followed in every well-ordered maintenance schedule.

Much attention has been given in determining the reserve strength of wire rope as a means of knowing how closely it is approaching an unsafe condition. Tests have been made on samples of new and used rope with this object in view, but no satisfactory method has been

devised that may be applied to ropes in service. Reserve strength is not as important as it first might seem. It is possible to have two used ropes both apparently in the same condition, but one will go to pieces in a few weeks and the other will give months of service before reaching a dangerous condition. Tests on two samples of used rope, one apparently in fairly good condition and the other with a large number of broken wires, showed that they both had about the same tensile strength. When such inconsistent conditions exist, the reserve strength of a rope becomes a minor rather than a major factor in determining its safe reserve life.

The conditions under which ropes operate, the rate at which broken wires develop in the strands, the location of these breaks are all equally if not more important than knowing the reserve strength of the rope. When applying these factors human judgement must be relied upon. In judging wire-rope, like other machine parts, if in doubt play safe has been found a good rule.

Problems That Train Real Engineers

OF ALL educational devices yet invented, the problem is perhaps the most effective. The success of an engineering teacher is often measured by his skill in devising and presenting problems designed to clinch the fundamental principles brought out in lectures, reading and class discussion. Some of the outstanding contributions to educational effectiveness at the summer school for engineering teachers now in session at Purdue University under the auspices of the Society for the Promotion of Engineering Education are demonstrations of problems that really educate.

Professor Wohlenberg, of Yale, for example, has brought new life to the teaching of heat-power engineering by showing how to place before the student for solution extensive problems dealing with the economic proportioning of surface in boiler units and other heat-transfer equipment. By lopping off from his courses many of the petty "frills" that too often grow out of the teachers passion for "coverage," Professor Wohlenberg finds it possible to devote as many as six class periods to a single problem in the economic proportioning of boiler and economizer surface. The student prepares his own basic curves showing the mutual variation of the various quantities involved, using the best available data, and finally arrives at a distribution giving the best "dollar" efficiency.

The problem is advanced, much like that frequently encountered in consulting practice; but its complete and painstaking solution by the student develops mastery of an economic approach to engineering problems that will serve him later in a thousand ways, even though he may never be called upon, in practical life, to lay out the heating surface of a boiler unit.

A man thus trained is far better fitted for real engineering work than the student whose mind is stuffed with half-digested details of obsolescent practice and principles he thinks he understands but cannot apply.

The opportunity provided by this summer school for teachers of mechanical engineering will certainly result is still further improvement in undergraduate instruction.

Designers Need the Operating Viewpoint

A POWER PLANT may be constructed in a year, but it may have to be operated for forty. This fact is something designers frequently overlook, with the result that the operator finds himself in some difficult positions. When machinery is installed, there is generally plenty of room to handle it. But, after the job is completed and everything is in place the space may be badly restricted and the handling of equipment made difficult when making inspections and repairs.

Designers sometimes do heed suggestions from operating engineers for improved operating facilities even when it does not require a rearrangement of equipment. When inspecting a new plant, the remark was made to the chief engineer, "They provided you with good facilities for handling this equipment." The reply to this was, "Yes, but we certainly had to fight to have them in the design." In this case the equipment referred to was two I-beams supported from the ceiling over a row of pumps. These beams were installed at very little cost, and made it possible to pick up any pump or motor on a chain fall and move it to where it could easily be dismantled. But why have to fight with the designer to get these conveniences?

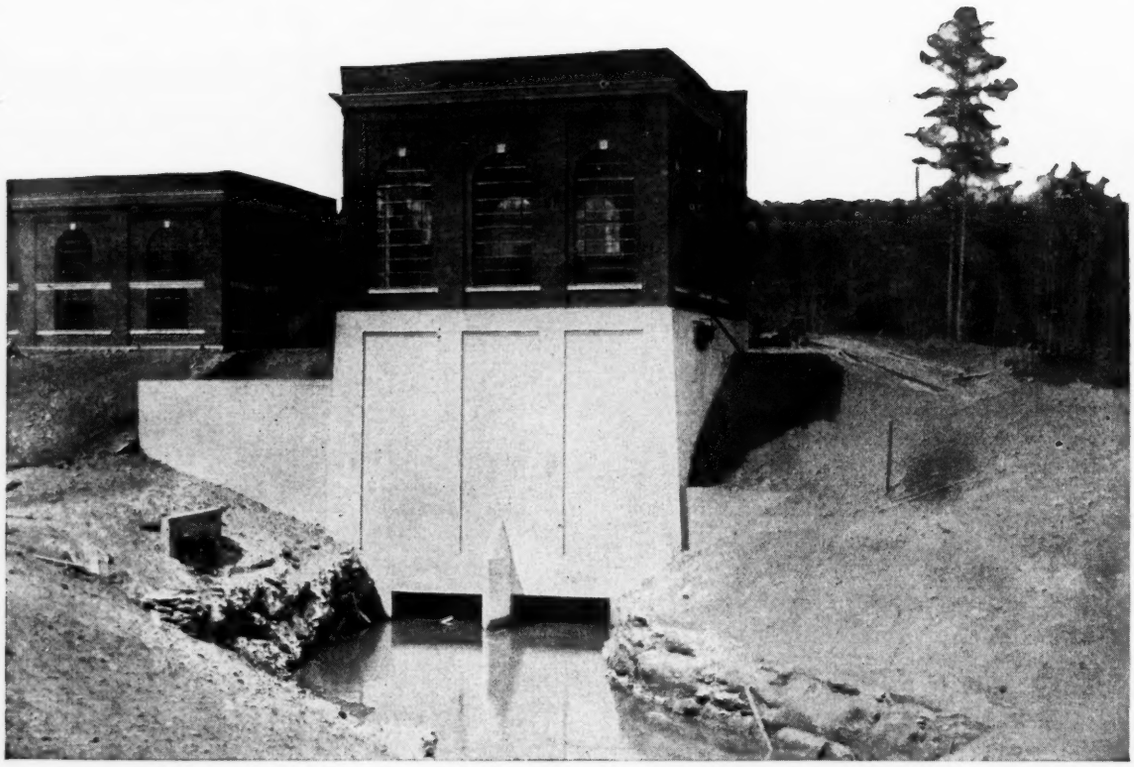
Engineer's Debt to the Manufacturer

OPPONENTS of our competitive business system sometimes point to the waste incident to duplicated effort, but they overlook the improvements in equipment and methods that result from this effort to excell in quality and service. Moreover, from this competitive struggle of manufacturers for a position of leadership in their respective specialties the power engineer reaps a harvest of savings that increase year by year.

At the same time, in order that he may attain the full benefit of a system from which he profits so much, the user must take care not to harass the manufacturer with useless or too heavy burdens. He must be ever mindful that the manufacturer has the task of maintaining quality, keeping price down to the point of meeting competition and still make a living. Wasteful service demands, duplication of engineering on plans and estimates, unethical playing of one manufacturer against another, and similar practices tend to weaken the equipment manufacturer and, in the long run, must reduce the value that the user receives for his money.

Fuller appreciation of each other's problems will react to the benefit of both manufacturer and user.

Power a Byproduct from City Water Supply



INSTEAD of allowing flood water to pass over the spillway, municipalities, when developing storage for their water supply, should raise the dam high enough to eliminate spilling loss. This excess can then be put through waterwheels and the power so generated sold or used for pumping. Spartanburg, South Carolina, followed this idea and finds it profitable, as the story will show.

This novel plan of developing a combined power and water supply by erecting a dam across the South Pacolet River about eleven miles from the city limits entailed a greater capital investment, for the power dam was more expensive than the low-head diversion dam that would have been sufficient for a water supply.

On the other hand, the higher dam decreased the pumping, for the filter beds could be placed at an elevation that permitted gravity flow from the storage.

The dam, which gives a maximum head of 63 ft. and an average of 57 ft. at the waterwheel, is of the hollow reinforced-concrete type, with a full concrete apron. Its length is 450 ft. and the height above the river's normal water level is 50 ft. The reservoir created by the dam floods 380 acres and gives a storage of 1,250,000,000 gal. Of this amount 900,000,000 is in the upper 15 ft. of the reservoir.

Water from the reservoir leaves the dam through a 78-in. steel penstock and flows 1,200 ft. to the power house, where the penstock divides into two 54-in. lines leading to the two 750-hp. S. Morgan Smith vertical water turbines. The penstock is controlled by a 5x7-ft. sluice gate at the dam and hydraulically operated gate valves ahead of each wheel casing. The power house is in the foreground of the headpiece. This building is of brick construction; the concrete basement which contains the turbines ends at the normal high-water mark, and the two 625-kva. General Electric 450-r.p.m. alternators are placed in the brick upper structure 30 ft. above the wheels; by this arrangement the generators are safe from flooding. The power house also contains the necessary operating accessories, including Lombard governors for the wheels, and the switchboard.

In a section of the basement apart from the wheels are placed three 2,800-g.p.m. 300-ft. head two-stage centrifugal pumps that take the water from clearwater well under the filters and force it through 15,000 ft. of 24-in. cast-iron pipe to a reservoir located at an elevation of 287 ft. above the city. Power for these pumps is supplied by the waterwheels.

The wheels are operated as continuously as possible, usually 16 hours daily. The power over that needed for pumping, is sold to the Duke Power Company at five mills per kilowatt-hour. This is a most advantageous

rate for the city, as the power company takes the energy when offered.

In the preliminary study the engineers assumed that

TABLE I—AVAILABLE AND EXCESS POWER

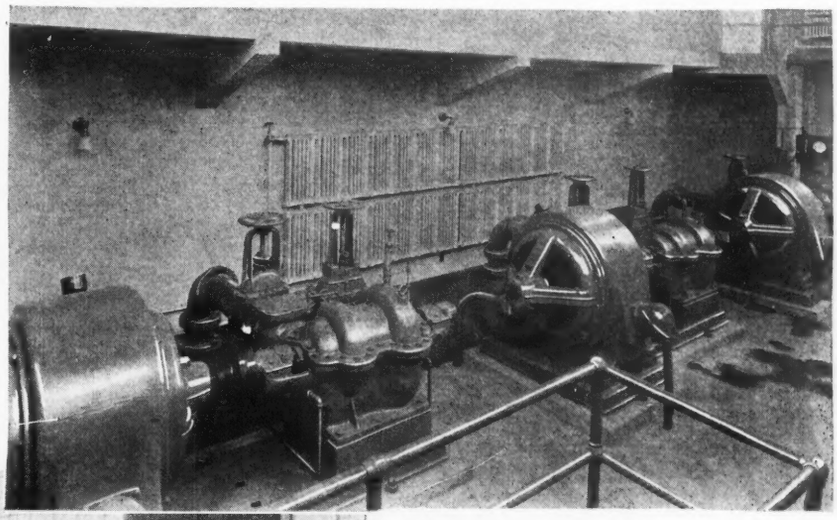
Per Cent of Time Turbines Are Operated	Total Horsepower Available at Turbines	Horsepower in Excess of Pump Requirements
100	100	0
90	200	0
83	300	42
75	400	142
67	500	242
58	600	342
51	700	442
44	800	542
39	900	642
34	1,000	742

in a short time the city demands would reach 4,000,000 gal. per day, although the present demand is about 2,500,000. A table was then calculated showing the quantities of power that could be developed with the plant operating at various percentages of the whole time. These values are based on the expected storage and a consumption of 4,000,000 gal. per day, which both reduces the water available at the waterwheels and increases the power needed for pumping.

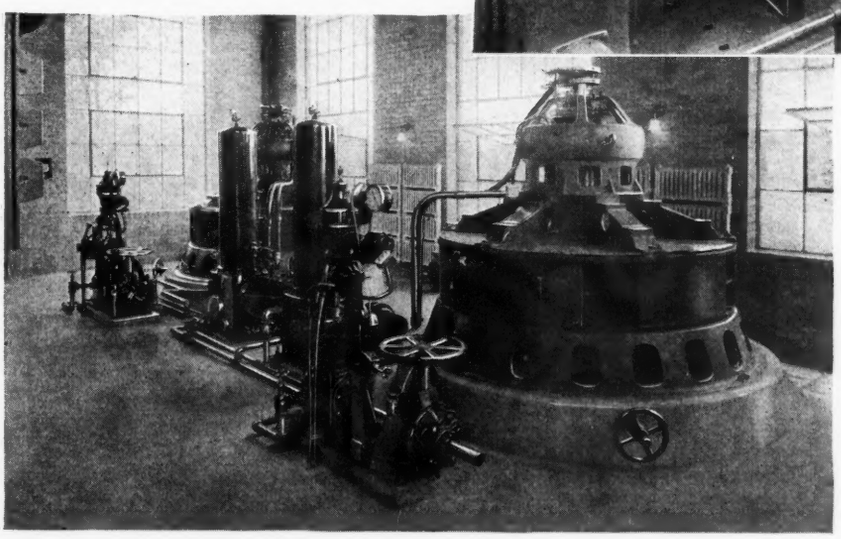
Strictly speaking, the power purchased should not be charged against the power plant, for under any circumstance this electricity for lighting would have to be purchased, but accounting methods make the item necessary. There are localities where the available water would be ample to supply all the electrical energy consumed in the town. The combination has all possible economic advantages; the extra labor there is insignificant, the cost of water developed is low and the total investment small compared to the annual net profits.

TABLE II—ESTIMATED OPERATION OF PLANT

Power sold, 1,677,000 kw.-hr. @ 0.5c	$8,385.00
Power used, 1,508,400 kw.-hr. @ 1.34c	20,212.56
Power saved by elimination of low lift pumping 200,700 kw.-hr. @ 1.34c	2,698.38
Total income	$31,295.94
Expenditure	
Power purchased	$224.00
Operating expenses	2,400.00
Interest @ 4.5 per cent	17,775.00
Sinking fund payment	4,846.65
Total	$25,245.65
Net profit	6,050.29



Below—The two 625-kva. waterwheel generators



Above—Two of the three high-pressure pumps

In making up the preliminary estimates the engineers made a study of the probable profits accruing from the power development, based on a construction cost chargeable to the power house of $395,000, and a plant life of 35 years, resulting in the data given in Table II.

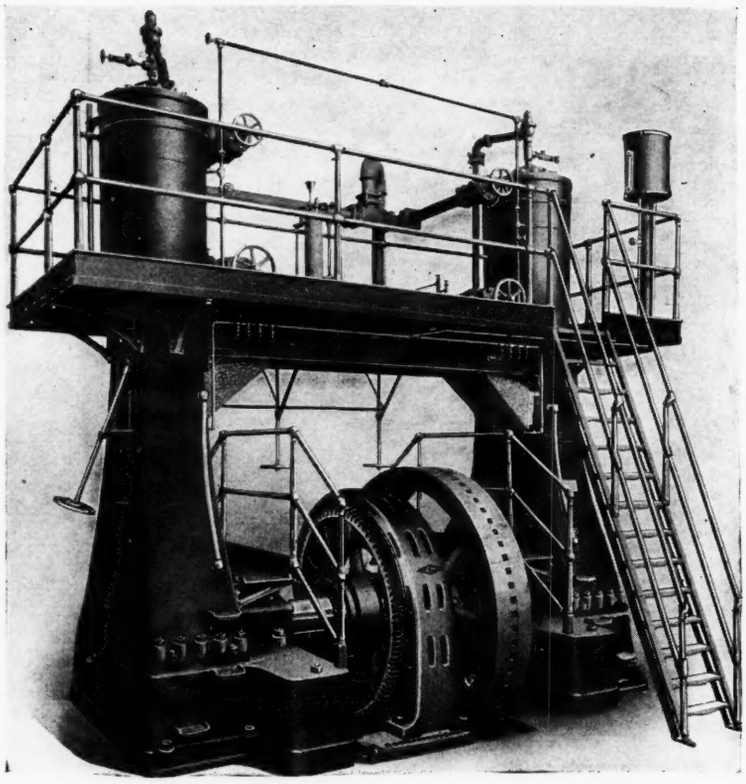
At present the plant is operated 16 hours daily, with one man on each of the two eight-hour shifts; this man attends to all the duties in the filter and power houses. To light the plant during the after-midnight period, energy is obtained from the Duke Power Company; the amount, however, is insignificant.

During 1928 the financial returns from the water power were better than had been expected. The department records are given in Table III.

TABLE III—WATER POWER OPERATION IN 1928

Power sold, 3,150,000 kw.-hr. @ 0.5c	$15,750.00	
Power used, 1,283,300 kw.-hr. @ 1.34c	17,204.00	
Total income		$32,954.00
Power purchased	$84.00	
Interest, at 4½ per cent	17,775.00	
Depreciation, 35 years, at 4½ per cent compounded	4,846.65	
		22,705.65
Profit from operation of power plant		$10,248.35

The profits obtained indicate that municipalities should not neglect the water power possibility of the water supply site. Not only will the pumping costs be more than offset, but the surplus power can often be used advantageously by the local power company with a good return to the water department.



OVER FIVE HUNDRED TONS OF REFRIGERATION *is employed at the Bridgeport plant in cooling the dies which press out the phonograph records. The water used for cooling the dies is first chilled to 40 deg. F. by flowing over stands of direct-expansion ammonia coils.*

Freezing the VOICE on a Columbia Record

BY G. GROW

INDUSTRY finds it cannot exist without refrigeration, for in almost every factory there is some process dependent upon the maintenance of a low temperature. Even the voice of a Caruso or a Scotti would not find immortality on the phonograph record if the engineer did not seize upon the advantages obtained by refrigeration. It is not fancy, but a real engineering fact when I state that the voice is frozen upon the Columbia phonograph record.

Years ago the record was at best an imperfect reproduction of the human voice, but, for the lack of comparison, was acclaimed an engineering and scientific achievement. What mattered if it squawked—it was as good as any.

But with the advent of the radio it was freely predicted that the talking machine's days were over. The prophecy would probably have been fulfilled if the manufacturers of phonograph records had not set to work to improve the quality of their product. So successful were they that today, in spite of the millions of radio sets, there are more records sold than ever before; in fact, the talking movies make use of the record.

In the Columbia Graphophone Company's plant at Bridgeport, Conn., there are manufactured daily between 50,000 and 90,000 records, depending upon the seasonal demand. These records consist of a composition center upon the two sides of which are glued circular sheets of paper made by a secret process.

The first step in the manufacture of a record is the registering of the voice upon a master record. This is coated with graphite and placed in an electrolytic bath, with the result that a thin sheet of copper is deposited upon its surface and reproduces in reverse all the minute indentations made by the needle under the influence of the varying tonal qualities of the singer.

From this is made the die used to imprint these variations upon the individual record. The dies are used on a hydraulic press, one for each side of the record. The blank record is placed in the press and steam at 100 lb. pressure is turned into the hollow dies for about 20 seconds. The hot dies are then brought into contact with the sides of the blank record, and the 100-ton hydraulic pressure forces the faces of the dies into the paper surface of the record. As the die is hot, the paper readily takes the impression.

If the die was withdrawn while still hot, the indentations on the record's face would speedily flatten out.

It is here that the refrigeration engineer is called into consultation. In former days, the steam was released from the dies and water at room temperature run through until the die and record were reduced in temperature—but this required too much time in this day of high-speed production. Consequently, refrigeration is encouraged to lessen the manufacturing time and to insure a better product.

The water used to cool the dies is now chilled to 40 deg. F. by flowing over stands of direct-expansion ammonia coils. From the tank below the coils the water is pumped into the main leading to the dies, and the return line brings the warm water, at about 50 deg. F. back to the cooling coils. In the manufacturing process the pressman turns the steam on for 20 seconds, holds the dies against the record for 20 seconds and then chills the die for an equal period; this gives an output of 60 records per hour. As in all processes, some workmen can increase this number, while others fail to make it.

The first refrigerating machine installed was a 100-ton De La Vergne horizontal double-acting motor-driven compressor. Increased factory output soon necessitated more refrigerating capacity, which led to the installation of a York vertical twin-cylinder single-acting compressor. This machine, which has a cylinder bore of 18 in. and a stroke of 28 in., was originally designed to be driven by a horizontal direct-connected Corliss engine. As the Columbia Company purchases its power, the engine was replaced by a 350-hp. General Electric synchronous motor turning at 100 r.p.m. At this speed the compressor has a rated capacity of 450 tons of refrigeration.

The crankshaft and pins are of cast steel, while the piston rods and wrist pins are nickel steel. As with all York machines, the suction valves are in the piston and the discharge valves in the cylinder heads. To eliminate danger from slugs of liquid ammonia, each cylinder head has a spring-loaded false head, which can act as a relief valve. By this design the clearance is practically zero, leading to a high volumetric efficiency.

There is, in addition, a 5x5-in. twin-cylinder compressor for pumping out.

The double-pipe ammonia condensers are arranged on the roof over the water-cooling room, with the receivers immediately below. These condensers are of the "flooded" design and are inclined to operate irregularly. The condenser serving the De La Vergne compressor is of the Block bleeder atmospheric counter-current design.

The capacity required by the factory is high, as a consideration of the process would indicate. Each unit of heat added to the die by the steam must be removed by the cold water. On the assumption that 10,000 B.t.u. of the heat in a pound of coal fired in the boilers reach the dies, it will be seen that each pound of coal burned per minute calls for a refrigeration duty of 50 lb. to remove it. Or each pound burned per hour requires a duty of over a ton, which is equivalent, approximately, to the consumption of one kilowatt-hour by the compressor for each pound of coal burned. Even at a rate of 1c. per kilowatt-hour the refrigeration expense is not small.

The same method of freezing a record could, with modification, be used in dress-goods printing and embossing. More and more the power-plant engineer is being called upon to assist processing by his steam and refrigeration services.

Trend Toward Underfeed Stokers Noted in European Developments

THE use of multiple-retort underfeed stokers is increasing rapidly in Great Britain and on the Continent, according to a statement in the report on foreign developments of the prime movers committee of the National Electric Light Association.

The operation of a new superpower plant in London has necessitated the selection of equipment of large steam-generating capacity. "Chain grate stokers," says the report, "have been limited to a maximum continuous steam-generating capacity of about 100,000 lb. per hour and, in addition, have not been successful in the use of highly preheated air."

A number of units operating with air preheated to 250 deg. F. equipped with underfeed stokers 37 tuyeres long and 11 retorts wide have been in service for some time, and, according to the report, are giving remarkable fuel-burning rates, with low air pressures. These plants, part of the London Electric Companies System, indicate that fuel-burning rates common in the United States can be exceeded with British coals because of their superior burning characteristics.

Stokers of this type having the largest projected area of any stokers ever built will soon be installed in the West Side Station in Berlin, Germany, says the article. These will be 20 retorts wide and 49 retorts long. There will be eight of such units used in conjunction with 2,580-hp. Borsig boilers operated at 410 lb. per square inch pressure and 800 deg. F., with feed water at 300 deg. F. The temperature of air for combustion will be approximately 500 deg. F., and the coal will have a calorific value of from 11,000 to 14,000 B.t.u. per pound as fired.

The largest steam station in Holland, the "Gurtruidenberg," is now installing multiple-retort underfeed stokers, and the Genoa station of the Milan Edison Company, in Italy, is similarly equipped. "There is a distinct trend," says the report, in conclusion, "toward the underfeed stoker in the large central stations of England, Germany, Holland and Italy, in which are represented the latest developments in European power plant practice."

Increase in Use of Electricity Summarized in Charts

THE tremendous increase in the amount of electrical energy consumed in the United States during the past 28 years is summarized in graphic form by the National Industrial Conference Board in Chart No. 208, which it has recently issued.

A nearly geometric rate of increase has raised the number of consumers from a total of less than 4 million in 1912 to over 23 million in 1928. During this period the total amount of electricity consumed has increased in corresponding fashion, from 9 billion kilowatt-hours in 1912 to nearly 70 billion kilowatt-hours last year.

The change in the per cent distribution is also illustrated. In 1912, the total consumption was nearly evenly divided between lighting, industrial power and railways, with industrial power just a few per cent in the lead. Last year industrial power consumed approximately two-thirds of the total output. Of the remainder, lighting consumed over 24 per cent and railways but 9 per cent.

INFLUENCE OF FUEL

On Diesel Operation

While oil engine designs are modern, the selection of the fuel oil to be used is still based on ancient and ill-founded methods. Fuel for oil-engine plants all over the world is still being purchased and tested for flash-point and gravity, which, in the author's opinion, is all wrong.

By Robert E. Bruckner
Test Engineer, Ingersoll-Rand Company

MANUFACTURERS base their fuel-consumption guarantees on precise fuel-oil specifications, which differ widely among manufacturers, even for the same type of engine. Users sometimes find their engines gumming up, smoking and knocking badly, although fed on fuel entirely within the manufacturer's specifications. After much activity by customer, service engineers and the chemical experts of the oil company, including exhaustive analyses for ring and chain compounds, aromatics, volatiles and residues, the recommendation is made that some other oil be tried, preferably one used before on a similar engine.

Fuel specifications benefit the user more than the manufacturer. They are intended primarily to serve not as a protection to the manufacturer through limiting his guarantee, but as a guide to the user when purchasing fuel, being of major importance in obtaining long and satisfactory service from the engine. How important is an understanding of fuel characteristics is shown by the result of tests recently run on a solid-injection oil engine.

The object of the tests was to compare the performance of various fuels in a locomotive oil engine at different loads. Comparison was made from the viewpoints of fuel economy, exhaust conditions, acceleration, cylinder pressures, detonation, lag in burning, and general performance of the engine. Behavior in actual operation in a switching locomotive was also studied.

The engine used for the test was a six-cylinder 300-hp. unit of ten-inch bore and twelve-inch stroke of the design shown in Fig. 1. The load was measured with a water brake. The fuel-injection system is made up of a single fuel pump for all six cylinders, which automatically maintains equal division of load to the several cylinders. During each upstroke of the pump plunger fuel is forced through a distributor to one of the six pairs of spray nozzles in the cylinder-heads. The distributor is shown at the front side of the engine. The spray nozzles are of the simple check-valve type, requiring no pressure-loading nor operating mechanism.

Engines of this general design are in use in locomotives all over the country, and normally operate quietly with clear exhaust over a wide range of both speed and load. They therefore provide an ideal means of testing the performance of different fuels.

Nine standard fuels were tested. They were:

1. The standard shop fuel, consisting chiefly of gas oil, viscosity less than 150 sec. Saybolt Universal, gravity 31 to 34 deg. Baumé.
2. A fuel containing 26 per cent aromatics, submitted by a railroad having trouble due to smoke and knocking.
3. Commercially pure gas oil.
4. Same as 3, with 15 per cent aromatics added.

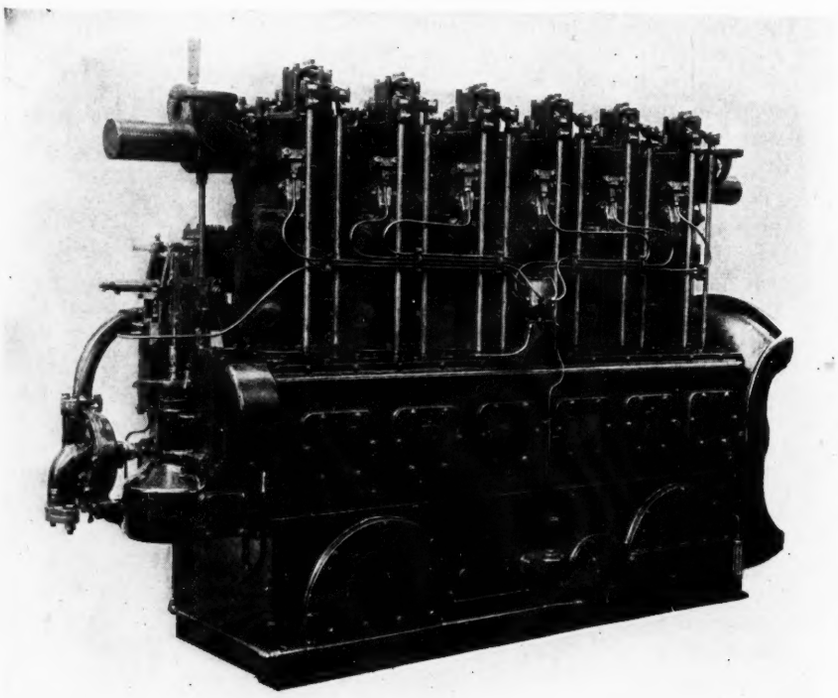


Fig. 1—The oil engine used in the tests was of the locomotive type

5. Same as 3, with 25 per cent aromatics added.
6. Same as 3, with anti-knock tetraethyl of lead added.
7. Commercially pure kerosene.
8. Same as 2, the railroad fuel, plus 10 per cent gasoline.
9. Railroad fuel, No. 2, with 12 per cent kerosene and 12 per cent gasoline added.

The term "aromatics" is given to such constituents of fuel oil as benzene and tolvene. These have a ring form of molecular structure and are difficult to ignite.

How the Tests Were Run

In running the tests, a six-gallon measuring tank was used, the tank and engine being drained of each fuel before trying the next. The standard shop fuel was tried first, followed by the four samples from the refinery and then the railroad fuel. After the last test attempts were made to improve the railroad fuel by admixtures of gasoline and kerosene. In each case runs were made at full, three-quarter, one-half and one-quarter loads, and fuel consumption, water and exhaust temperatures, exhaust condition and maximum cylinder pressures were noted.

The performance in shop test of all the fuels tried was entirely satisfactory with the sole exception of the railroad fuel and its admixtures, Nos. 2, 8 and 9.

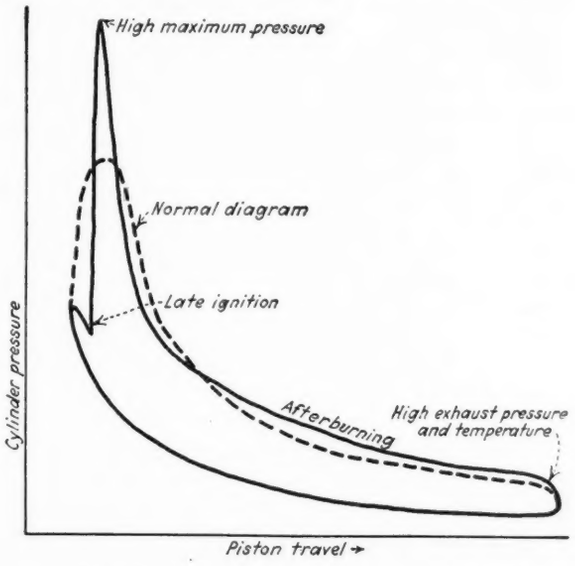


Fig. 2—The indicator diagram reveals knocking at full load

The aromatic fuels submitted by the refinery, Nos. 4 and 5, showed an exhaust temperature only 3 per cent higher than normal, and only a 5 per cent increase in cylinder pressure, with practically the same fuel economy. Evidently, the percentage of aromatics in a fuel is no criterion of its performance in an engine.

On the other hand, the tests of the railroad fuel with or without various percentages of gasoline and kerosene showed full-load combustion pressures from 100 to 200 lb. above normal, with continuous knocking in all cylinders and a smoky exhaust. An indicator diagram taken during this test is shown in Fig. 2. The quarter-load combustion pressure was abnormally low, being below the compression pressure, as shown in Fig. 3. The quarter-load combustion was irregular, with a puffy exhaust and an occasional knocking. Addition of gasoline and kerosene, even up to 12 per cent of the total fuel, improved the performance but little; the 10 per cent gasoline mixture, No. 8, was worse in all respects than the railroad fuel alone. The addition of 12 per cent kerosene, Fuel No. 9, caused a slight reduction in cylinder pressure and less smoke and knocking.

These facts are of peculiar interest, especially in view of the entirely satisfactory performance of pure kero-

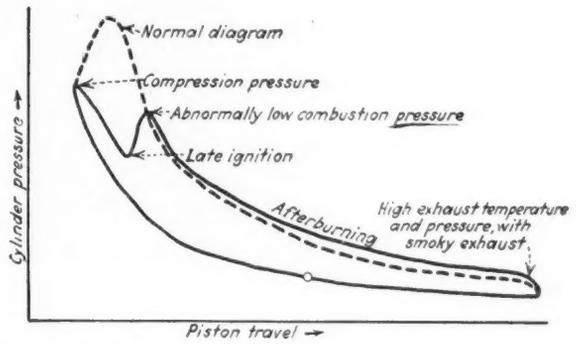


Fig. 3—At low load combustion was slow

sene, Fuel No. 7. Kerosene does not vaporize readily, but has a low ignition point, being a loose-complex compound. Gasoline vaporizes readily, but is a simple compound with a high ignition point. This explains the much better performance of kerosene in a compression-ignition engine. Direct test data on the ignition behavior of a proposed fuel would evidently be a highly desirable item in a fuel specification.

Fuel oils are complicated mixtures of complex organic compounds difficult to analyze with anything like the accuracy required to predetermine chemically their behavior in the high-temperature high-pressure ignition process of the Diesel engine. The ignition process itself consists of a chain of complex chemical reactions which occur with lightning-like rapidity in the small fraction of a second between injection and combustion of the fuel mass as a whole.

Chemical Phases of Ignition

Until recently it has been generally assumed that ignition in a Diesel engine consisted chiefly of two steps: First, evaporation of the small drops of injected fuel by combined spray-action and heat from the compressed air; second, rapid gaseous ignition and flame propagation through the homogenous vapor-air mixture so formed, in a manner similar to the gasoline engine after the spark discharge.

However, recent investigations in Germany, by Doctor Kuehn and others, on the physical processes of atomization and evaporation, show conclusively that the evaporation occurring in the few hundredths second available is insignificant, so that ignition must occur in the droplets themselves and not in the vapor created by their evaporation.

Further investigations on the chemical phases of the ignition process, by Otto Alt, Tausz and Schulte and others, indicate that the chemical reactions involved are much more numerous and complicated than hitherto supposed. Ignition occurs in the droplets themselves, probably by the heat-absorbing formation of organic peroxides reaction between a small fraction of the fuel first injected and part of the oxygen in the compressed air. The heat required to effect this peroxidation is obtained from the compressed air. These peroxides are

highly unstable. They decompose almost instantly with the rapid change of pressure and temperature conditions occurring in the engine, releasing a large amount of heat, which serves to ignite the main fuel mass and start rapid combustion.

From these investigations it appears that the flash point, which really measures the vapor-forming tendency of the fuel, has nothing whatever to do with the ignition process in the Diesel engine, although of the first importance in the automobile gasoline engine, for example, where the engine can operate only on fuel having a pronounced vapor-forming tendency. So far as oil engines of the compression-ignition, or Diesel, type are concerned, the flash point of the fuel used is a matter of interest chiefly to the fire-insurance underwriter, as determining the safety of storage in open tanks.

Specification for Diesel Fuel

The rational specification for a Diesel fuel as to ease of ignition in the engine, therefore, consists in stating the time required for rapid combustion to take place when the fuel is brought into contact with air or with oxygen at a given pressure and temperature. This quality can also be conveniently specified as the temperature at which ignition takes place in a given time, usually a few seconds, when the fuel is exposed to air or oxygen at given pressure. This temperature has been named the "ignition point" of the fuel in question.

Relatively simple instruments for measuring the ignition point have already been developed, chiefly in Germany. These ignition-point testers give as close an actual measure as is obtainable without direct test in the engine. They could readily be constructed by the oil-engine manufacturer, whose chemical staff is competent to conduct the test. To be practically certain beforehand that the fuel will give satisfactory results in continuous operation, an engine user contemplating the purchase of a new fuel oil need merely send a small sample to the manufacturer.

Specific Gravity of Diesel Fuel Oil

Another Diesel fuel specification borrowed from the gasoline-engine industry is that of specific gravity, usually expressed in degrees Baumé. The specific gravity of an oil has little to do with its spray-injection characteristics within the range of gravities now used, and nothing to do with its ignition and combustion characteristics beyond an accidental relation between gravity and chemical constitution. In fact, investigations indicate that the heavier oils have a more complex chemical structure and are more likely to contain compounds that readily form the peroxides characteristic of ignition in the oil engine.

The only limit to the specific gravity of the oils that can be burned in the solid-injection Diesel, assuming a favorable ignition point, is the viscosity. Too viscous a fuel cannot easily be pumped through the small tubes and valves characteristic of the injection system, unless heated to bring the viscosity down to the permissible maximum. For these reasons it is becoming the practice to specify viscosity rather than gravity.

Ignition-point testers being practically unknown in this country, it is difficult for one manufacturer acting alone to specify ignition point instead of the irrevelant flash point. But viscosimeters are common. A typical fuel-oil specification for a high-speed solid-injection engine, such as that described, is given here:

Fuel Oil Specifications

Fuel oil should be hydrocarbon oil that is free from grit, acid and fibrous or other matter likely to clog or injure the valves.

The viscosity at 70 deg. F. should not be higher than 150 Saybolt Universal.

The flash point should not be lower than 150 deg. F.

The sediment and water content should not exceed 1 per cent.

The sulphur content should not exceed 1 per cent.

Even high-speed engines of the type shown easily burn oils ranging in specific gravity from 20 to 42 deg. Baumé, provided the viscosity and ignition points are within the permissible limits and provided the oil will flow freely through the piping.

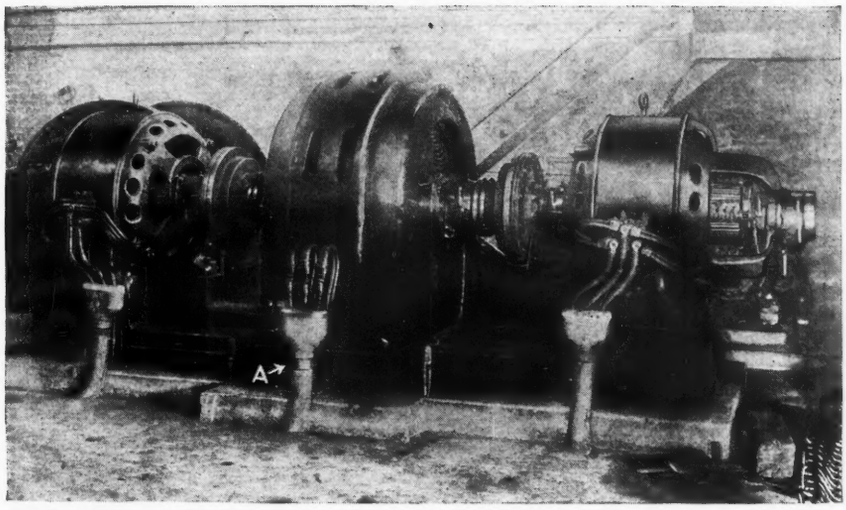
Stuck Piston Rings and Blow by

Recent discussion has centered around the responsibility of gummy residues in the fuel for causing stuck piston rings and blow by. It is difficult to conceive how a particle of gummy residue in the injected fuel can pass through a white-hot high-pressure combustion zone, undergo no chemical change, and deposit itself on a piston ring. This can happen only with oils such as asphalt-base Trinidad oils, and then only at light loads, when fractional distillation occurs inside the engine cylinder. It is much easier to see how a mixture of overheated lubricating oil and carbon can collect around a ring until it sticks. However, gummy residues in the fuel oil may clog the small valves and passages in the injection system, especially when a hot engine is shut down long enough to cool. The specifications should, therefore, state the maximum percentage of gummy residue allowable.

The sulphur-content specification appears to have been dictated by what the refineries could furnish rather than by test to determine the maximum safe percentage. Engines have run continuously on 2 to 3 per cent sulphur without injury. Mexican fuel oils often contain 2 to 3 per cent of sulphur in the form of organic sulphides, the free sulphur or loose sulphur compounds being negligible. Such oils can be burned for long periods without injury to the engine, provided the engine is started and stopped on sulphur free oil to prevent condensation of sulphurous fumes and moisture inside the engine and exhaust lines, thus insuring against corrosion. In any case means must be provided to prevent any sulphurous gases from blowing by the piston rings into the crankcase to mix with moisture in the lubricating oil.

New Specifications Needed

Present-day specifications need revision to the benefit of manufacturer and user alike. The percentage of aromatic compounds does not determine the value of an oil as a Diesel fuel; direct ignition-point test is necessary. It is suggested that the revised code of specifications be more liberal with sulphur content, especially when the sulphur is present as an organic compound and corrosion is minimized by starting and stopping on sulphur-free oil. The ideal specification should also limit the viscosity at a given temperature, not the irrelevant specific gravity. And the ideal specification should call for the ignition temperature and time at a stated pressure in air or in oxygen, not the irrelevant flash point. Fuel purchases can be made, then on a completely rational and scientific basis, with ultimate great benefits to the entire industry.



Machine frame grounded to conduit system at *A*

Grounding Electrical Equipment Makes Operation Safe

By Marin Phillips

Electrical Superintendent
International Paper Company, Niagara Falls, N. Y.

MANY electrical accidents are caused by current flowing to ground through a workman's body when he is changing fuses, pulling switches or making repairs. It is an excellent precaution for safety to install ground detectors on all ungrounded power systems to indicate when a ground appears on the system due to the insulation failing at some point. If the system is kept free from grounds there is not so much danger of receiving severe shocks. However, it should not be assumed there is no danger in touching one side of a high-tension line if the other side is free from grounds. A ground is likely to occur at any time. Even if it does not, there is the possibility of a person in connection with the ground receiving a severe shock when coming in contact with one high-tension wire even though the system is insulated. There is also the possibility of receiving a severe shock when touching a low-tension wire that is in accidental contact with a high-tension circuit.

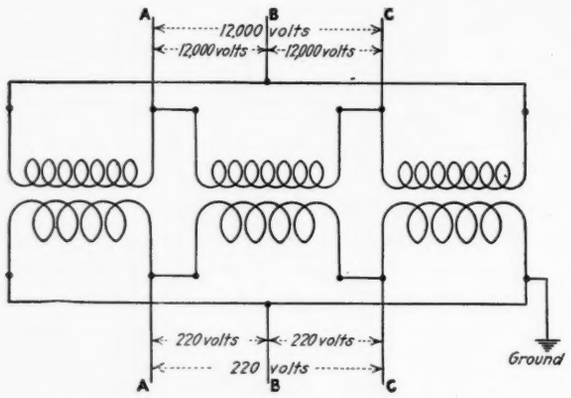
Most alternating-current power systems have one phase of the low-tension circuits permanently grounded to guard against the possibility of having it accidentally charged with the high-tension voltage. Take the case of an industrial plant that purchases its power. The power will most likely be supplied over a transmission line at high voltage and a bank of transformers used to step down to plant voltage, which will generally be 220, 440 or 550 volts. Assume that the high-voltage transmission is 12,000 volts and that the low tension is 220 for use in the plant. If one phase is permanently grounded as in the diagram, there will be practically zero potential between this phase and ground. A potential of 220 volts will exist between the other two phases and ground. With one phase permanently grounded the maximum voltage that can exist between any phase and ground is 220 on the low-tension side. If all phases on the low-tension side are kept free from grounds, there is a possibility of getting a dangerously high voltage in the plant on the low-voltage lines. This can be caused by the high-voltage winding in the transformer coming in contact with the low-tension winding.

To ground or not to ground electrical equipment and how to maintain low-resistance grounds after they are made are problems that frequently beset the engineer. These and other questions on the safe operation of equipment are discussed.

In cases where the plants have their own generating equipment and power is used throughout the plant at the generated voltage, there will be no advantage or need of permanently grounding any part of the circuit. In such a plant it will be advantageous to have the system free from ground, and an honest endeavor should

be made to keep all windings and circuits insulated.

The practice of permanently grounding one phase of the secondary side of power transformers seems to be open to question. Some localities' and power companies' requirements are that one phase on the low-tension side of the transformers shall be permanently grounded. I have had experience with one power company that will not connect the transformers in for service until this is done, while in other localities the power com-



Ground on one phase of low-voltage side of transformers

panies will not allow the low-tension side to be permanently grounded.

For transformers having a secondary voltage of 110 or 220 for industrial-plant distribution, I favor permanently grounding one phase on the secondary side. This will guard against high voltage in the plant due to a cross between the primary and secondary winding in the transformer, and thus the workmen will not be exposed to a greater hazard than the ordinary plant voltage. If the secondary voltage is 440 or 550 and one phase is permanently grounded, it will expose the workmen to greater danger of shocks and burns than if the system were free from grounds.

Framework Should Be Permanently Grounded

The framework of all electrical equipment should be permanently and effectively grounded. This equipment includes switchboards, transformers, generators, motors, and motor starting equipment, switch cabinets and the like. Particular attention should be paid to the size of ground wire, method used when applying the ground wire or copper strip, what is used for a ground, placing of responsibility to see that all equipment is properly grounded and kept grounded. The size of the ground wire or ground bus will depend on the size of the equipment being grounded. For grounding motors and other equipment in industrial plants, wire smaller than No. 6 solid B. & S. should not be used. Solid wire is preferred for grounding purposes, as it can be bent and shaped to fit close to the foundation and around corners out of the way and will stay in position better than stranded wire. This is essential since there is always the danger of trucks catching the ground wire and breaking the connections loose if they are not properly protected.

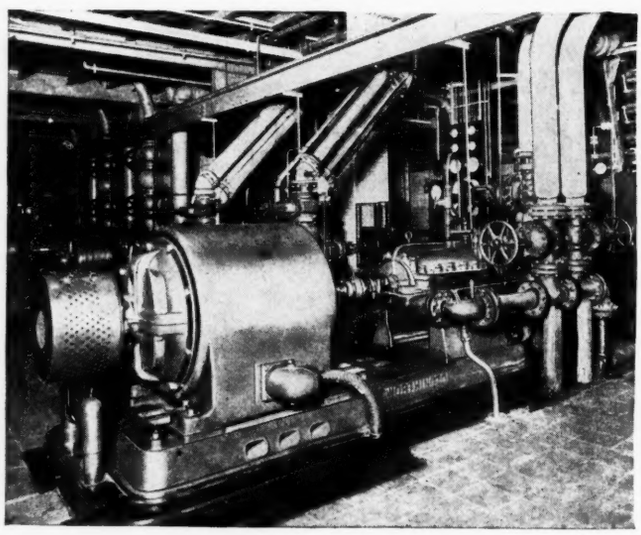
It is not uncommon to find large motors, generators and transformers grounded with a No. 10 wire. I have seen the frames of 150- and 200-hp. motors, as well as large power transformers, grounded with No. 12 or 14 wire. Such wire has practically no mechanical strength to protect it against being torn loose from the equipment that it is protecting. Its current-capacity is so low that in case of a fault to ground sufficient current may flow to fuse the ground wire or destroy the solder on its connections. This would then leave the equipment frame alive and invite an accident to anyone who came in contact with it.

When looking over the way ground connections are applied to equipment in industrial plants, it will be noticed that the wrong method is applied quite frequently, particularly if there are no general instructions relating to how the grounding should be done. When no such rules are in force a workman sent to make a ground connection will, in most cases, use the first piece of wire that happens to be handy. This practice is usually carried out regardless of the size of the wire. The ground wire will more than likely be applied by winding one end around a pipe with paint on it and the other end around or under some screw or bolt head on the equipment being grounded.

Care Should Be Used in Applying Ground Connections

A good rule to follow when applying ground connections to equipment is to be as careful about making them as one would if it were on a motor. A terminal lug should be soldered to the end of the wire that is to be connected to the equipment. Make the connection by placing the terminal under the head of a bolt or screw. When it is possible a bolt or screw should be chosen that will not be disturbed when making the ordinary maintenance repair work on the equipment.

There is little use to ground electrical equipment



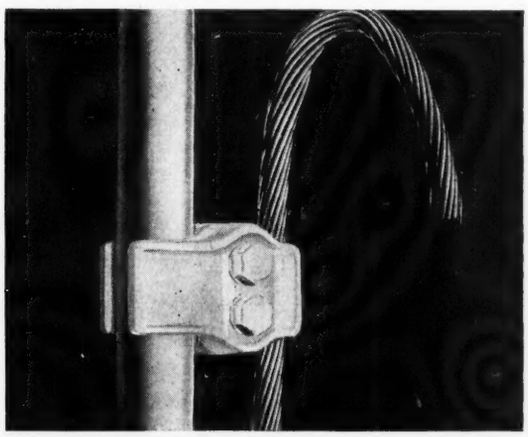
When a motor is mounted on the same bed plate with a water pump its frame is effectively grounded

if it is not going to be kept grounded. It is common to find ground wires disconnected from motors and starting equipment. The greatest cause of ground wires being left disconnected on equipment is the careless way of applying them. The connections are placed under the head of bolt or screw that it will be necessary to remove before repair work can be begun. A good example of this is when a ground wire is placed under the head of a screw holding the cover on a piece of equipment, such as a fuse or a switch cabinet. Another

example is the placing of a ground wire under the head of a bolt holding the end frame on a motor or under the head of a bolt through the bearing cap. In some instances the ground wire will be placed under the head of a screw holding the oil pan on a starting compensator. When equipment is grounded in this manner, the ground connection will have to be disconnected every time repair work is started.

The proper method to use when grounding electric motors is to drill and tap a hole near the bottom of the stator frame for a machine screw or bolt; otherwise the ground connection should be so located that repairs can be made with the machine in place without having to disconnect the ground wire. On some types of starting equipment and switches a special screw and terminal lug are furnished for the ground connection. These connections should be used when provided. If no special means for grounding is available, then a hole should be drilled for bolting a terminal lug. If a little forethought and caution is used when applying grounds, they can, in most cases, be so located that they will not have to be disturbed during the life of the equipment. The importance of using good judgment in making ground connections to electrical equipment cannot be overemphasized.

If the ground end of the wire is to be connected to a flat surface, such as a plate, bus or steelwork, it also



One type of regulation clamp for connecting ground wire to a pipe

should be provided with a soldered terminal lug. The ground object should be drilled to receive a screw or bolt for connecting this lug. If the end of the ground wire is to be connected to a pipe, an approved ground clamp with means for bolting a terminal lug to it or an approved ground clamp not requiring a soldered connection should be used. File and clean the surface the same as for any current-carrying connections before bolting on the ground connection. This is important if a good contact is to be obtained. Paint on the pipe may insulate the connection, rendering the ground ineffective.

When applying ground connections to electrical equipment, the main object is to get a well grounded object to connect to, so that a low resistance to ground will be obtained. For ordinary low voltages (600 volts or less) the ground connections can be made to the steelwork of the building or to the water piping. Where connections are made to the former, the steel should be well grounded at convenient points throughout the building. When convenient it is better to make the connections to the water piping.

In localities where it is permitted it is better to make all ground connections to the sprinkler-system piping, as the sprinkler piping extends to all parts of the building. Another good point in favor of the sprinkler system for ground connections is the improbability of that piping being disconnected and leaving the equipment without ground protection. In making ground connections to the sprinkler system piping, a large motor or other equipment should not be grounded to a small pipe.

Great Care Necessary in Grounding High-Voltage Equipment

Great care should be taken to assure that high-voltage equipment positively is well grounded. No high-voltage equipment should be grounded to the inside piping or steelwork of an industrial plant if it is possible to avoid it, since there is danger of someone getting a fatal shock. The best way to ground high-voltage transformer banks and oil switches is to connect, outside of the plant, to the main water pipe, ahead of all shutoff valves and hydrants. The connection is made by bending a busbar around the pipe and bolting it tightly in place. Allow the busbar to extend up to the surface, for making the ground connections.

The placing of responsibility to see that all electrical equipment is grounded and kept that way may be accomplished with good results as follows: All construction hands should be instructed that when a new piece of equipment is installed, it must be grounded and that the job will not be considered completed unless it is well grounded. Men of the maintenance crew responsible for repairs on the equipment should be instructed that they must replace all ground connections that they disconnect when making repairs. Workmen should also be instructed that their job will not be considered finished until they have all ground connections replaced. After all the equipment is grounded it can be kept that way by carefully exercising these instructions. It is absolutely necessary to have some such rule in force, otherwise the problem of keeping the equipment well grounded is very nearly hopeless.

Another good way to keep tabs on the ground connections is to instruct the motor tender or inspector that it is his duty to keep a close watch for disconnected or broken ground wires. He should be instructed to repair them or report at once to the proper authority if he is unable to make the repair. In an industrial plant but a small number of workmen are acquainted with the dangerous hazards of electricity and understand how to avoid danger, and the majority have no realization of its workings. It is these workmen who must be protected against shocks, burns and mechanical injuries, owing to the fact they are not aware of the hazards around electrical apparatus.

If a water or a steam seal is used on turbine bearings the runners or casings must be inspected for scale. If such a deposit is extensive with water seals, the source of the water should be changed if possible. Condensate is frequently employed for this purpose. It is essential that this sealing water be of a very high grade. With steam seals, if there is a scale formation, there is probably also a scale formation on the blading and nozzles, and a change in the source of the feed water or its treatment is desirable.

Efficient Operation of

CHAIN GRATE STOKERS

By P. M. Sykes and H. M. Matson
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Dresser Station, Indiana Electric Corp.

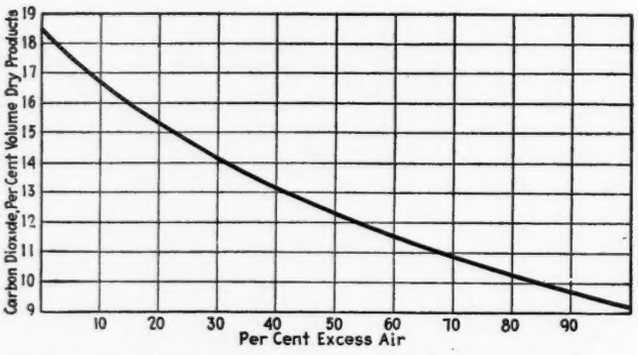

Fig. 1—Relation between excess air and CO_2 for fifth-vein Indiana coal

WHEN coal is burned on chain grates, distillation of hydrocarbons takes place in the first zone and may progress into the second zone. Ignition and distillation are brought about by reflection of heat by the ignition arch, the heat waves emanating from the third or fourth zones (where rapid oxidation is taking place), being deflected downward upon the green coal.

The hydrocarbons distilled off as gases burn to carbon dioxide and water vapor if the air supply is ample and the temperature sufficiently high. If the air supply is excessive, the hydrocarbons are chilled and pass off unburned, so in most cases it is necessary to have a lesser blast in the first zone than in the second zone.

If the air supply is deficient, the distilled gases, being at a high temperature, will "crack," forming soot, hydrogen and methane. The higher the temperature the more carbon will be freed. Then, if chilled below the point of ignition while still floating in the gases of combustion, which might be easily caused by excess air from following zones of infiltration of air through the boiler setting, the carbon will appear as smoke or soot over the stacks.

After distillation of hydrocarbons has taken place, the remaining constituents of coal are pure carbon in the form of coke, together with ash and refuse. Oxidation of coke takes place after and sometimes during distillation, but the coke must be completely oxidized or burned before the end of the grate is reached in order that no ashpit loss may be sustained. This necessitates a fine adjustment of zone dampers.

The usual practice is to allow the maximum amount of air to pass through the second-zone dampers with the supply of air in succeeding zones tapering off to the end of the fire. Zone dampers beyond the end of the fire should be closed. Variations in size of coal require different zone pressures, but relatively the same distribution is used.

Ash and refuse remaining after all carbon has been oxidized usually pass into the ashpit dark and cold. However, with high boiler ratings and long fires, this ash may retain a small amount of the heat of oxidation and heat reflected from the rear arch and will pass into the ashpit slightly radiant. This condition does not necessarily mean that combustible is being lost in the ashpit.

Carbon in burning to CO_2 generates 14,600 B.t.u. per lb. If there is a deficiency of air, a portion of the carbon burns to CO and liberates but 4,500 B.t.u., and unless the necessary oxygen is added to the CO at a sufficiently high temperature to produce CO_2, the difference in B.t.u. is lost up the stack in the form of unburned gas. This further addition of oxygen for complete combustion is best accomplished by means of secondary or over fire air injected into the combustion chamber. The addition may be accomplished by steam siphons, blower fans or by direct connection to the forced-draft duct. It has been found practically impossible to force sufficient air for complete combustion through a fuel bed that has no definite holes. The coal procured from the fifth vein in Indiana has the characteristic of uniting with oxygen in the air in theoretically perfect combustion to form 18.43 per cent CO_2. This is, of course, impossible to attain in boiler practice as the formation of CO in some portion of the fuel bed offsets the high CO_2 advantage. Fig. 1 expresses the relationship between CO_2 and excess air with fifth-vein Indiana coal.

Secondary air over the fire has the added advantage of producing turbulence in the products of combustion, thereby assuring an intimate mixture of the possible CO and the air injected and also preventing stratification of the gases.

If more air is admitted to the boiler than is necessary for complete combustion of the fuel, the products of combustion will be diluted with excess air and an analysis of the flue gas will show low CO_2. Fig. 2 indicates the relation between per cent loss per pound of fuel fired and percentage of CO_2 in the flue gas, and also indicates losses sustained due to CO or unburned gas. The percentage of CO_2 in the flue gas should, of course, be carried as high as possible consistent with negligible CO and ashpit loss.

Draft loss through the fuel bed is dependent upon the method of firing, rate of combustion, depth of fuel bed and size and kind of fuel. For utmost efficiency a nearly balanced effect should be produced by mutually adjusting the pressure created by the forced-draft apparatus and chimney action or its equivalent. The forced-draft pressure should be just sufficient to overcome the resistance of the fuel bed. The uptake damper should be so regulated that the draft in the uptake will overcome the resist-

ance in the boiler setting and maintain ten-hundredths to fifteen-hundredths inches of water draft in the furnace.

Some coals burn to better advantage if they are moistened or "tempered" before being fed to the furnace. A properly moistened crushed coal has less resistance to air flow than either very wet or very dry coal and hence promotes even combustion. The coal may be tempered on conveyor belts or buckets, in the storage bunkers or in the stoker hoppers. The amount of moisture to be added varies with the fuel, but 2 to 4 per cent is advocated.

The thicknesses of fuel beds determine to a large extent the amount of excess air admitted through the fuel bed. A thin fuel bed has the tendency to admit air through holes in the fire. A very thick fuel bed necessitates slow grate travel with probability of burning through and admission of air at the back. Consequently, a mean must be established for each boiler load, grate speed and size of coal.

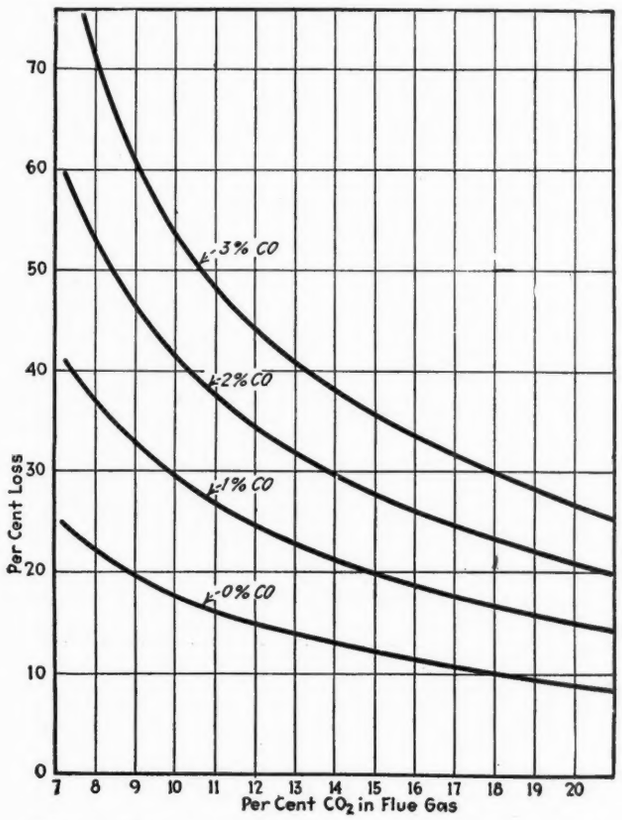

Fig. 2—Percentage of heat in fuel lost for various percentages of CO_2 and CO

The best practice in steam power plants carrying a base load all or part of the time, is to carry as many boilers as possible at a constant efficient rating, taking the load swings on one or more boilers. The boilers in poor condition, due to fouled or slagged tubes, poor or imperfect arches and so on, should be used as swing boiler or boilers under ordinary conditions. With proper diligence on the part of the operator, the steam pressure can be maintained nearly constant by means of the swing boiler or boilers.

Coking or firing in the boiler hoppers should be avoided, as this tends to make a ragged fuel bed with consequent admittance of excess air at the end of the fire. Fires in the boiler coal hoppers may burn for several hours without being noticed, either in banked or steaming boilers. It is sometimes the practice to quench these fires by means of a water hose. This practice is detrimental to gates and gate tile in that the former is in all probability at a red heat and when quenched with cold water will shrink and crack. Many gate tile are ruined in this way. Small slice bars should be used for cleaning the hoppers of burning coke.

The problem of slag or fused ash is best solved by means of water or steam and water hand slagging, the bottom rows of tubes being slagged each day preferably during banked hours.

The Human Element a Big Factor in Production Costs

By P. H. Wilson

THERE have been numerous articles appearing recently, giving all kinds of suggestions for reducing the cost of generating power in the central station and industrial power plant, as well as for change in machinery and methods for lowering the cost of production in all lines of industry.

There is one element that is almost, if not entirely, eliminated from any plans for lowering production costs; one that should be most conspicuous in any method or short cut that is put into use; namely, the human element.

Every worker expects pay for his work and will do a sufficient amount to hold his job; but how many take more than passing interest in what they are doing? Are they altogether responsible for this lack of interest?

Does your foreman commend you for a job well done or does he fail to see the good points of your work? Does he "bawl you out" for your errors or does he come to you in a quiet, nice way and show you just how to do the job without an error? In my opinion the latter method gets best results.

I know two men in the same plant who handle the men under them in an entirely different way. One of them gets practically twice as much production as the other, and always knows just why a part of a machine was broken; while the other never gives the worker a chance to make any explanation and never knows whether it was weak construction of the machine, which could be remedied, or carelessness on the part of the operator or an accident.

The first man goes along with his work, and if any employee under him breaks a machine, or if he finds that another cannot make the proper adjustment to get the best operation, he shows the employee how to make the adjustment or he has the broken part repaired. If the machine was broken through carelessness or inattention, the operator is told in a quiet, friendly way to be more careful. If this must be repeated several times, the employee is tried on something else. If the same trouble is had after a trial on different jobs, he is dismissed from the service.

All employees working under this man will do anything for him, helping him out in case of breakdown or, if necessary, working overtime without pay.

Now the other man gets in to work a little late in the morning, goes to his desk, finds a broken part of a machine, stalks off to the machine and proceeds to "bawl" the operator out; and the operator may not have been at fault. Before repairs can be made to this machine, other troubles come up, and this man is "bawling" and cussing all day. Strange as it may seem, the "big boss" appears to think this is the best man of the two, because he is always "firing" somebody and having to break in new hands.

Refractory Versus Bare Walls

AN EDITORIAL in *Power* several weeks ago on "Bare Water-Cooled Furnace Walls" has brought to light some interesting data in support of the refractory covered wall. The curves here reproduced, in Fig. 1, were plotted from tests on oil-fired boilers of the Scotch, B & W marine and Express types, the first and third having been made at the Navy Fuel Oil Testing Plant, Philadelphia Navy Yard. The highest efficiency in the case of the Scotch boiler, whose furnace is completely water cooled without refractory covering, was 80.5 per cent. This was at a heat liberation of 50,000 B.t.u. per cubic foot per hour. The curve drops off very rapidly with increased rates and the unaccounted for loss rises with equal rapidity. Higher efficiencies throughout are shown for the B & W marine and the Express types which employed refractory furnaces. With the latter the unaccounted-for loss remains below 2 per cent up to 225,000 B.t.u. per cubic foot heat liberation. Even at 300,000 B.t.u. liberation the unaccounted-for loss is no higher than the lowest similar loss with the Scotch boiler and Mayflower burner.

The curves in Fig. 2, made from tests with pulverized coal on a Scotch marine and a B & W marine boiler, show similar results. The tests on the Scotch boiler were made at the Philadelphia Navy Yard and those on the B & W boiler were conducted by Thomas B. Stillman at the Bayonne plant of the Babcock & Wilcox Company, and reported in a paper before the Society of Naval Architects and Marine Engineers. Both sets of tests were made with direct-fired mills of the ball-and-tube-type, turbulent burners were employed and the fineness of the coal was comparable.

As before, it will be noted that the efficiencies with the Scotch boiler reached a maximum between 40,000 and 50,000 B.t.u. heat liberation per cubic foot and dropped off rapidly at higher rates. This, it has been pointed out, is indicative of a critical point with completely water-cooled furnace such as is exemplified in the Scotch boiler.

The furnace in the Bayonne boiler had four refractory walls and the boiler tubes were the only cooling surface exposed to the flame. The radiation and unaccounted-for loss was considerably lower than in the case of the Scotch boiler, and separate tests showing the carbon loss alone varied from 0.6 per cent at 27,000 B.t.u. heat liberation up to 1.7 per cent at 75,000 B.t.u.

With reference to stationary practice, attention is called to the Calumet tests as reported in the N.E.L.A. prime movers' report of August, 1928, and those made at the Fordson plant, as reported by Henry Kreisinger in a paper before the A.S.M.E. in December, 1927. The

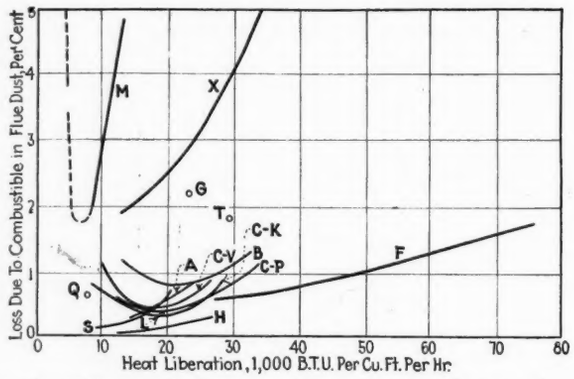

Fig. 4—Effect of furnace liberation on losses due to combustible in flue dust

loss due to combustible in the flue dust as given in these tests is plotted in Fig. 3. Both tests were fired by bin systems, and the coal had substantially the same fineness, although there was some difference in the burners.

Of further interests in this connection is a paper on "Removal of Ash and Loss of Carbon from Boiler Furnaces," by D. S. Jacobus and E. G. Bailey given before the Second International Conference on Bituminous Coal, at Pittsburgh, last November. Fig. 4 (Fig. 1 in the original paper) shows the carbon loss for various installations, curve *F* being that from the marine boiler at Bayonne; *K* that from the Calumet boiler; *A* the Columbia Station, having all refractory walls and vertical firing; and *B* the Buffalo General Electric boilers with slag-tap furnaces and refractory covered water-cooled walls. The Fordson curve is marked X.

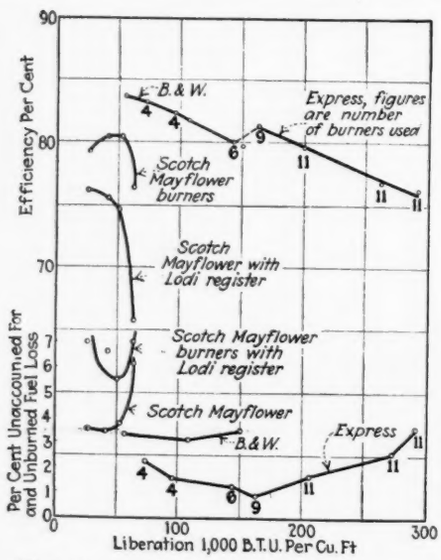
Efficiency Per Cent
Per Cent Unaccounted For and Unburned Fuel Loss
Liberation 1,000 B.T.U. Per Cu. Ft
B. & W.
Express, figures are number of burners used
Scotch Mayflower burners
Scotch Mayflower with Lodi register
Scotch Mayflower burners with Lodi register
Scotch Mayflower
B. & W.
Express

Fig. 1—Comparative performance of oil-fired Scotch, B & W and express types

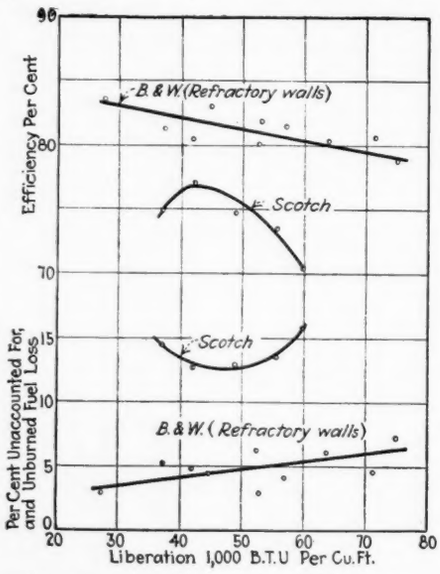
Efficiency Per Cent
Per Cent Unaccounted For, and Unburned Fuel Loss
Liberation 1,000 B.T.U Per Cu. Ft.
B. & W. (Refractory walls)
Scotch
Scotch
B. & W. (Refractory walls)

Fig. 2—The unaccounted-for loss with the Scotch boiler is lowest at between 40,000 and 50,000 B.t.u.

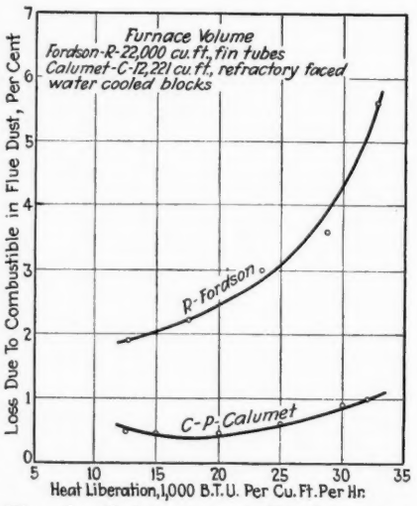
Furnace Volume
Fordson-R-22,000 cu. ft., fin tubes
Calumet-C-12,221 cu. ft., refractory faced water cooled blocks
Loss Due To Combustible in Flue Dust, Per Cent
Heat Liberation, 1,000 B.T.U. Per Cu. Ft. Per Hr.
R-Fordson
C-P-Calumet

Fig. 3—Calumet and Fordson tests compared as to loss in combustible in flue dust

Power Plant Clerk Keeps All Records

Stores keeping and scheduling of maintenance, repairs and inspections are also among his duties

By Walter N. Polakov*
Consulting Engineer, New York City

In this, the fifth of a series of standard instructions for power-plant management, the author gives a simple outline of the duties of the power-plant clerk. The information should prove of value to any plant of sufficient size to employ such a man.

NO TWO plants are alike. Principal functions may be the same but the organization needed for their performance will vary with local conditions. If the clerk takes care of plant records, some one else, often the maintenance man or master mechanic, or even the chief engineer, takes care of instruments, tests, etc. In larger plants clerical duties frequently should be split between purely clerical and more or less technical. In such instances the latter are performed by a power-record man, whose duties are described in the next instruction.

Duties of Power-Plant Clerk

The power-plant clerk's duties consist of:

1. Collecting, keeping, calculating and representing graphically and otherwise all plant records.
2. Keeping the time of all power-house employees.
3. Acting as the custodian of power-house stores.
4. Keeping schedules of maintenance, repairs and inspections.
5. Assigning proper charge symbols on all entries.
6. Attending the tickler.

Responsibilities: He is responsible to the chief operating engineer for:

1. Immediate, reliable and adequate records.
2. Efficient and orderly conduct of office and good care of all office property.

And to general storekeeper for:

3. Good care and account for sub-store in the power house.

Authority: He has the authority to:

1. Request and obtain all pertinent information, data, costs, prices, etc., from any department or employee for the purpose of correct and complete power-house records.
2. Sign his name on all reports and records of the department verifying the correctness of same.
3. To initial requisitions and other matters in absence of chief operating engineer if specifically authorized by him to do so.
4. Hold the key to the power-house storeroom, make stores issues and give out the key to authorized person only upon written and timed receipts.
5. Check up on fuel delivered, check railroad weights, handle bills of lading and other documents, schedule fuel to storage and to service, and keep perpetual inventory of coal and oil received, issued and on hand.

Condition of Work: The power clerk reports for duty at . . . a.m. and works with one hour interval for lunch until . . . p.m. His desk is located in the power house office. He is paid by the week and does not work Sundays or overtime except when he falls behind in records, in which case no extra payment is made. If assigned to record tests, etc., when not on regular duty, he is paid on the basis of hourly operator on the hourly pro-rata of his wages.

Co-operation: The clerk co-operates closely with:

1. The maintenance foreman by attending to schedule of repairs and instructions and to job board.
2. The boiler house foreman in order to clearly establish the causes and conditions of lost bonus and reasons for recommendation to allow bonus.
3. The purchasing, the stores and the accounting departments.

Next week Mr. Polakov will discuss the setup for testing and taking care of instruments and the handling of record data pertaining to the generation, distribution and utilization of steam and power.—Editor.

DAILY POWER PLANT REPORT

MR._____ PLEASE NOTE_____

SUMMARY DATE_____	SHIFTS 1	2	3
COAL CONSUMED, TOTAL			
COAL CONSUMED, BANKING			
COAL CONSUMED, POWER HOUSE			
WATER EVAPORATED			
BOILER PRESSURE			
TEMPERATURE OF WATER TO ECONOMIZER			
FACTOR OF EVAPORATION			
EQUIV. EVAP. PER LB. OF COAL			
B.T.U. PER POUND OF COAL			
EFFICIENCY OF BOILERS			
COST OF COAL PER M. LBS. OF STEAM			
K.W.H. GENERATED			
CU. FT. FREE AIR COMPRESSED			
FOOT-POUNDS HYDRAULIC WORK			
ICE MACHINE			
STEAM FOR MANUFACTURING			
% OF IDLE PLANT CAPACITY			

Sample form for daily report of the power-plant clerk

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Why Not Gas as a General Fuel?

By J. GULICK
Collins Western Corporation
Los Angeles, Calif

THE following discussion of fuel is the result of a study of present conditions. Many details are not mentioned because they are either common knowledge or tabulated process and operating information, all of which is easy enough to catalog if necessary. The conclusion of the study is that we should get busy and heave overboard most of our customary fuel practice, not because of the inherent joy of smashing things up, but because it will be good business for the community generally.

Imagine a national network of pipelines, radiating from super-gas-plants located at fuel deposits. The economics of this idea is that the chemical byproducts, incidental to fuel reduction and refining, are high-value, small-bulk materials of such kind as are required in synthetic manufacturing. The development of such byproducts is fostered by the commercial aspect of gas manufacturing; that is, everything goes to the market.

Fuel is a low-priced commodity and generally its weight and bulk per dollar are large, which means that the transport charges are high. There are localities where the cost of some particular fuel is composed entirely of transportation and storage charges. In this class comes any grade of refuse from the coal breaker; also many large, practically unworked lignite deposits; and, in addition, all sorts of refuse fuels, such as hog fuel and bagasse.

Fuels that are outside of the class mentioned and that are considered as high grade, are mine-run and bunker coal, domestic anthracite, fuel oil and fuel gas. The first three have much higher transport charges than the other two; and, of these, fuel gas costs less to transport than fuel oil, though of course the field of use for fuel gas is limited to the distribution pipe line. However, it so happens that a pipe line costs much less to build than a railroad or a tanker fleet. While most railroads will develop other tonnage to help defray the operating charges, a tanker fleet must counter-load with molasses or other liquid cargo to hold down the cost of fuel-oil transport. Outgoing cargoes to balance the tanker are scarce in any port, and the general procedure is to return in water ballast.

All the fuels named, as well as anything else that will burn, exhibit the common property of being convertible into fuel gas.

The logical manufactured fuel gas for an industrial service is mainly dependent upon the distance between the gas plant and the point of use. Where it is necessary to have a distribution line, economics point to a higher heat value than 150 B.t.u. per cu.ft., which is about the heat value for the average producer gas. And if we wish to supply gas through a pipe line to customers, the statute law steps into the case and says that such gas must be about 500 B.t.u. per cu.ft. or more. Economics also has considerable to say on the subject, the gist of which is that if fuel gas of about 400 B.t.u. is permissible, the over-all cost of manufacture is about one-half of what 500-B.t.u. gas now costs. And it so happens that the 400-B.t.u. gas is more satisfactory today for fuel purposes than the 500-B.t.u. gas.

A comparatively small pipeline operated at some pressure will transport as much heat in fuel gas as a railroad can transport in coal or fuel oil. This pipeline is automatic, just as is a municipal water supply. Also, it will pay interest charges, while rail equipment must handle considerable tonnage only to keep out of the red.

Fuel oil can also be delivered through a pipeline, but because of a characteristic of fuel oil, which at low or freezing temperatures does not flow easily, it is necessary to assess the fuel-oil pipeline with a high pumping charge. A large or small high-pressure gas distribution system costs less to operate per heat quantity than a fuel-oil distribution system.

The laws of combustion tell use that the only thing that burns in any furnace is gas, regardless of the nature of the raw fuel itself; but, as we have been burning fuels in the raw form since the stone age, the custom of burning solid fuels is pretty firmly established. The burning of any fuel requires that we supply and mix the quantity of oxygen chemically required by the fuel; about 3 lb. of carbon requires 8 lb. of oxygen and each pound of hydrogen also requires 8 lb. of oxygen.

This is apparently very simple, but we have not yet established standard methods of mixing. It is essential that the air and fuel mix thoroughly before the burning can be completed, and it is obvious that mixing fuel gas and air is much easier than mixing air with coal, oil or other fuels. This sounds better if we say that combustion is a high-affinity gas reaction, the speed of which can be controlled by the degree of mixing prior to burning; and, as the mixing refers to molecular mixing, it should be obvious that what is the natural course of events with air and fuel gas can only be approximately reached with solid or liquid fuels and air.

It is common practice to build large furnaces for steam boilers, in the attempt to secure complete burning of the fuel. Experience with solid and liquid fuel dictates this practice. Since pulverized coal has come into use, it is necessary to build more expensive and larger furnaces. The life span of these furnaces is short, and as we increase the heat release per cubic foot of furnace volume, the life is shorter—refractories cannot stand the gaff of the high temperature. The boilers, however, thrive on high temperature; in fact, within the range of temperatures possible with cheap fuels, it can never be too high for the boiler. Many boiler troubles are fostered by the reverse condition. Boiler scale, for instance, is automatically eliminated from the active heating surface when we develop high temperatures. The difference in the expansion rate between steel and scale causes what thin scale is on the water side to flake off quickly, so the water can come in close contact with the tube wall.

However, it so happens that if we use fuel gas and mix it with the correct amount of air before it enters the furnace, we can practically eliminate the necessity for the furnace structure itself; that is, the spacing of the boiler tubes is such that this space can function as the furnace space necessary for combustion. This calls for the adoption of the method known as "surface combustion," which means that the gas fuel burns at very high rates by coming in contact with red-hot surfaces. In the case of the boiler these hot surfaces are cast-iron rings around the tubes. The efficiency of this procedure is about 90 per cent for any size of boiler and any class of service, although of course some types of boilers are better than others.

So far very little work has been done to adapt fuel gas to steam boilers. Economics points to high-pressure fuel gas (up to about 10 lb.) as the most suitable. Some pressure at the point of use is needed because it automatically supplies the energy required to pre-mix and ignite the fuel.

Today fuel gas can be manufactured from any solid or liquid fuel at surprisingly low cost where the 24-hour quantity is around 100 million cubic feet, which roughly represents the heat requirements of a city of about 100,000 population. Also hydraulic, high-pressure storage and variable, high-low-pressure distribution, will give a flexibility of service operation that would supply gas to the customer, domestic and industrial, to meet any demand. A layout of this kind would be based on the maximum demand, while the plant additions would conform to the growth of the community to keep ahead of the market.

An arrangement of this kind would mean that the gas company would supply practically all the fuel that is used in the community. As a result, cities would be freed from smoke, soot, cinders, coal-storage requirements and coal-transportation facilities. Also, there would be rapid elimination of obsolete boilers and fuel-burning equipment.

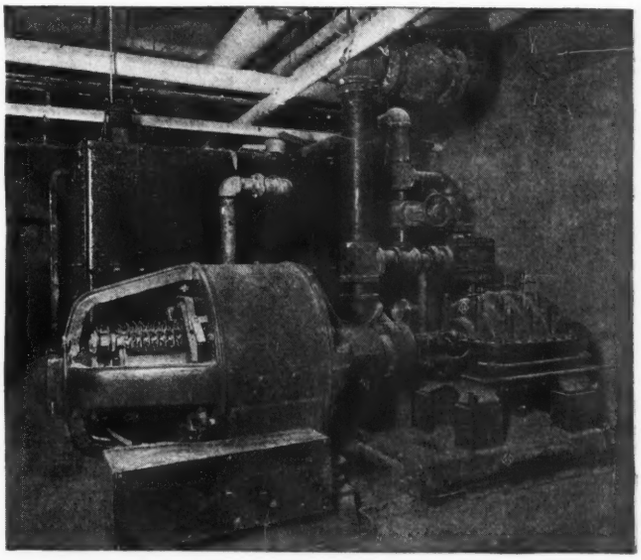
This improvement in boilers is one of the very important details in the industrial scheme—a basic function—and its proper and economic solution depends more on the general distribution of fuel gas than on all other factors put together. Steam is the best of all power mediums. Steam equipment, in the opinion of the writer, is able to develop electric power in prime movers above 5,000 kw. at cost figures that push every other form of power out of the picture. An important detail is that forced-circulation, high-pressure boilers using fuel gas and the surface combustion process make the 10,000-sq.ft. boiler of such size that it can be moved through the ordinary 36x84-in. doorway.

Cheap, high-pressure fuel gas is the solution of boiler, metallurgical heating and other industrial heating problems and also of the domestic heating problem, rural as well as urban. Some day the thing will be a fact instead of a dream. If economics tell us that our order of progress requires cheap, high-pressure fuel gas, which in effect means automatic fuel, then the sooner we can establish the thing as the regular course of business the less it will cost the community. For it is a fair observation that economic law exacts payment when the need for a thing is a fact and it is introduced at too slow a rate. That is, when the need for a thing is there, we pay for it whether we get it or not.

Largest Centrifugal Fire Pump in an Office Building

By H. L. Smith
Industrial Engineering Department
General Electric Company

THE pump shown in the figure is for fire service in the Chanin Building, New York City. It is driven by a direct-current compound-wound motor rated 300 hp., 1,150 to 1,750-r.p.m., 230 volts, and is capable of delivering 750 gal. of water per minute against a head of 920 ft. The building is 56 stories (702 ft.) tall, and the pump must furnish water through standpipes to the top of the building.



Direct-current motor rated at 300-hp., 1,150 to 1,750 r.p.m. connected directly to a fire pump

This is probably the largest centrifugal fire pump ever installed in an office building. It is also the largest direct-current motor, operating at this speed, using the end-shield type of bearing construction. The advantage of end-shield bearing supports is that they enable a much smaller base to be used and make the unit as a whole more compact. A manual-type starter is used, the speed being changed by field control.

The general construction is that of the stronger type of general-purpose motors. The end shield and bearing on the coupling end are split to permit easy removal of the armature or bearings.

Modernizing a Department Store Power Plant

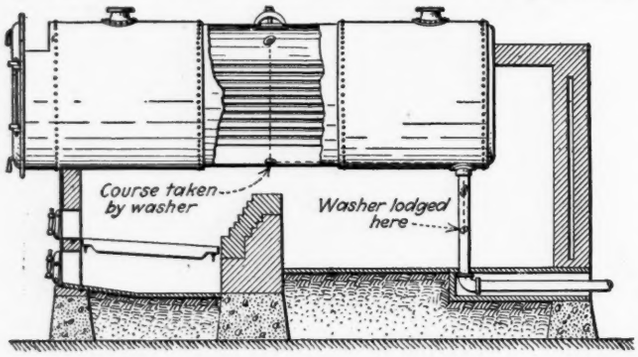
During the last five years Macy's Department Store, in New York, one of the two largest in this country, has been rebuilding and expanding its power plant. A change from coal to oil firing has been made, the power system has been revamped from a two-wire to a three-wire distribution, the generating plant has been expanded to a capacity of 3,350 kw. and a large air-conditioning system has been installed, the compressors of which are driven by exhaust-steam turbines. The story of these and other changes, together with operating results attained and the large savings effected, will appear next week in *Power*.

Right Out of the Plant

Washer Shuts Down the Boiler

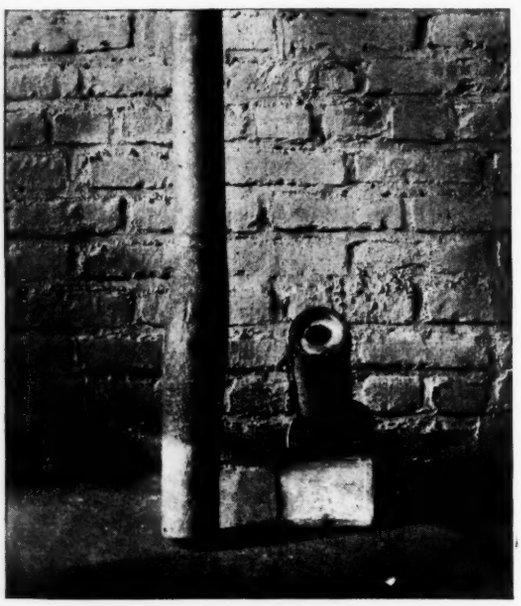
SURGICAL patients have been sewed up with instruments inside, and boilers have been put into operation with loose nuts and hammers where only water is supposed to be. But the incident I am about to relate is unique—in my own experience, at least.

The blowdown pipe on a return-tubular boiler developed a leak. Removal of the casing of the protective



Since the washer is a tight fit in the pipe, it is hard to understand how it went down so far

brickwork revealed a bad bulge in the pipe. In the middle of the bulge was a small opening where the metal had been burned through. The pipe was removed and cut through just below the bulge with a hacksaw. As luck would have it, the cut came a bare quarter-inch above the source of the trouble, a large washer lodged tightly in the pipe. Scale had lodged and solidified



The section on the right shows the washer in the pipe

above the washer, leading to the bulge and the leak. Investigation showed that the washer belonged to the manhole plate. The attendant who dropped it in while working on the boiler had failed to report the occurrence.

Rowayton, Conn. M. P. BAXTER.

Storage Bin Baffle for Use With Steam-Jet or Pneumatic Conveyors

TO THOSE of us who have always believed in the ultimate perfection and thus in the popularization of steam-jet ash conveyors, the constructive suggestion of P. W. Lamson in the May 7 number was very welcome. There can be no question as to the logic of using cast-iron pipes of non-machinable hardness in contact with such abrasive and—if moist or wet—corrosive material as ashes, clinkers and even sand.

What has delayed the general popularity of steam-jet ash conveyors in connection with hand-fired, stokered and powdered-coal-burning boilers was the rather high consumption of steam with the early installations, as well as the poor design of the various fittings—elbows, rebound units, baffle boxes, etc.—used in them, together with the fact that the exposed wearing surfaces were either wrongly located or were far from hard enough to resist successfully the sand-blast action of fine ashes and the groove-cutting of clinkers moving at high velocities.

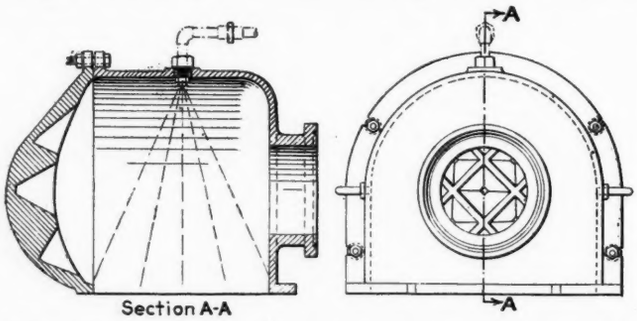


Fig. 1—Baffle box with small section cavities to hold material

In my experience, steam consumptions have been reduced as much as 50 per cent in the last ten years, while the item of maintenance—involving the design and hardness of the liners—has been cut down to an even greater extent. The latter was due to quite extensive experimentation with other than all-metal wearing surfaces, so that the suggestion of Mr. Lamson is quite in the right direction.

Unless chilled, the hardness of either steel or cast iron is much lower than that of concrete, glass, etc., which has been proved by the experience of Mr. Lamson. Were it possible to produce chills in cast-iron liners of more than about $\frac{3}{8}$ in. depth, their chances to resist successfully the severe abrasion would be greater. As an alternative, liners have been used that were of a hard composition and of such character that does not require additional chilling, so that their full thickness—up to $2\frac{1}{2}$ in.—was uniformly hard throughout. Such liners, however, proved to last longer than ones of the same thickness having a chilled wearing surface of limited depth, which blends into a softer substance of cast iron and of necessity forms the major part of the thickness in the liner. It must be understood that hard iron is also brittle iron and that chilling causes still greater brittleness, the limit of which is the ability of the liner to resist impacts produced by larger clinkers moving at high velocities.

The disadvantage of cavities filled with cement, glass and the like is, as Mr. Lamson states, that some of such filling would break away and form a pocket. The result of this is that the flow of the conveyed material (ash, sand, etc.) receives a check in its high velocity motion, since such pockets are bound to form obstructions the overcoming of which calls for more steam—or air, in case of sand conveying.

To overcome such a condition the cavities ought to be divided into rather small sections, which, due to their limited size, are more likely to retain a filling formed by the material conveyed (fine ash or sand) even if they were not purposely filled with concrete mixed with broken glass, etc. An approved method of this is shown in Fig. 1 which is a baffle box of a steam-jet ash conveyor.

The other method is the embedding of pieces of such material as carborundum or the like in the wearing surface of the liner, which together with the chilled or hard cast-iron surrounding these pieces offers a combined wearing surface that is most resistant to the severest

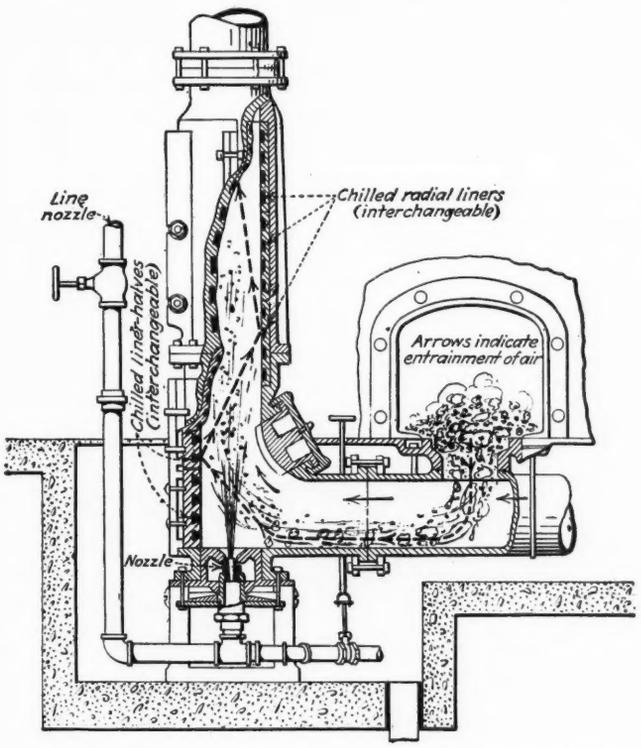


Fig. 2—Elbow unit with dovetailed inserts in liners

wear and still prevents the formation of pockets, which, for reasons of efficiency in steam or air, should be avoided. Care should be taken, however, that these pieces be placed in a staggered position, so as to prevent groove-cutting, else such composite liners would gradually be cut into strips, since the hardest iron is still much softer than such products of the electric furnace as artificial corundum, known by the trade names carborundum, borolon, etc. The hardness of the latter is next to that of a diamond and it is being used exclusively in the manufacture of grinding wheels. It is unexcelled for liners as well.

In a thickness of about $2\frac{1}{2}$ in. in a liner the pieces embedded can be as large as $1\frac{1}{2}$ in., which is considerably more than the deepest effective chill. With the diverging sides of these pieces away from the wearing surface of the liner, they become dovetailed in the surrounding iron, so that they will not be dislodged until the iron is worn off by the sand-blast action of fine ashes, which is a slow process of attrition. In the path of the straight lines of clinkers, these pieces are bound to slow down considerably the inevitable groove-cutting to which even the hardest iron would succumb.

Fig. 2 shows a 90-deg. elbow-set with such liners in a steam-jet ash conveyor. The path of the material within it, as indicated by the diagram, shows the inevitable rebound after the first impact of the various sizes, which, due to their velocity, develop a momentum and are bound to strike at least once more within the conveyor before they are forced to straighten out beyond the rebound fitting by the force of the jet of steam or air.

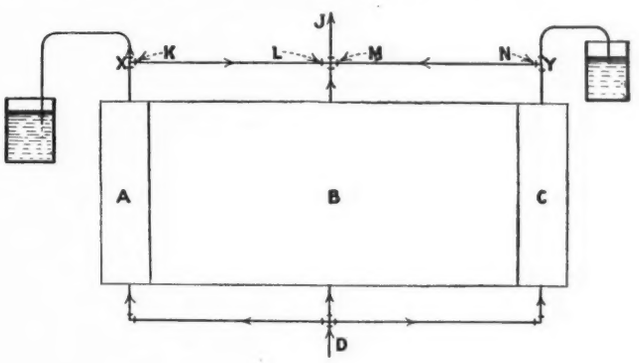
EUGENE HAHN,
Lancaster, Pa. Lancaster Iron Works, Inc.

How To Test Cylinder Walls of Air Compressors for Tightness

RECENTLY, I was called upon to inspect a second-hand air compressor the purchase of which was being considered. The machine in question was a two-stage, cross-compound unit having cylinders $25\frac{1}{2}$ and 40 in. in diameter, with a stroke of 30 inches.

While inspecting this machine I was much concerned regarding the condition of the metal between the inside of the cylinder and valve passages, and the water jackets. After a little thought I decided upon a method of test that is extremely simple and, I think, original—at least I have never heard or read of such a test being made.

Details of the method of test referred to are as follows: The valve *D* on the water inlet line was closed so that water could not enter the jackets. The water-cooling discharge line was broken and plugged at points *K*, *L*, *M* and *N*. At points *X* and *Y* rubber hose was attached, the end of each piece of hose being submerged in water. A short length of hose was also attached to the discharge from the cylinder jacket at *J*, and the end of this likewise was submerged in a pail of water. The



Arrangement of connections for air-leakage test on compressor cylinder

theory of the test was that after the machine was started a defective casting would be indicated by air bubbling through the water. Under these conditions the low-pressure cylinder was tested and found perfect. The high-pressure cylinder, however, when put to this test showed a decidedly bad leak. The leak was found by removing the cylinder head, keeping valve *D* closed and applying hydrostatic test through connection *J*.

Parnassus, Pa. JOHN C. HOAR.

Multiple-Effect Compression in the Ice Plant

THE article by F. P. MacNeill on this subject in the May 21 number of *Power* was of great interest to ice-plant engineers. While I concur in the opinion that "the precooling system with two suction pressures shows a real gain," I also agree that "certain factors not mentioned will operate to reduce the gains shown."

The first difficulty in the way of realizing the gains indicated is the fact that in the average ice plant there is not a sufficient proportion of the total refrigeration that can be done at a 35-lb. suction pressure. In other words, the precooling of the liquid ammonia to 21 deg. and of the water to 32 deg. will not supply enough 35-lb. suction vapor to supercharge the cylinders of a machine that has sufficient displacement to complete the freezing of the ice.

To make this clearer, let us follow a few figures. One pound of liquid ammonia at 150 lb. gage has a total heat value of 137 B.t.u.; at 35 lb. gage it has 66 B.t.u. Hence 137 — 66 = 71 B.t.u. per lb. will be required to cool the liquid ammonia in the precooler. The latent heat at this pressure being 552 B.t.u. per lb., 71 ÷ 552 = 12.9 per cent of the ammonia will be evaporated in cooling itself. This will leave 1.00 — 0.129 = 0.871 lb. of ammonia to go on to the evaporator in the ice tank, while 0.129 lb. will come off as vapor at 35 lb. gage.

In the tank at a pressure of 15 lb. gage the latent heat of evaporation is 569.6 B.t.u. per lb. And the 0.871 lb. of liquid will supply 0.871 × 569.6 = 496 B.t.u. of latent heat. Some of this, however, will be used in the further cooling of the liquid ammonia. The heat of the liquid at 15 lb. gage being 42 B.t.u. per lb., the heat required to cool the liquid will be 66 — 42 — 24 B.t.u. per lb., or 24 × 0.871 = 21 B.t.u. Hence 496 — 21 = 475 B.t.u. of net refrigerating effect is available in the tank.

Now Mr. MacNeill gives 190 B.t.u. as the quantity of heat to be removed from one pound of can water at 70 deg. F. to change it into ice at 15 deg. F. for tank losses. This will give 190 × 1.1 = 209 B.t.u. per lb. of ice produced. Of this 70 — 32 = 38 B.t.u. will be removed in the water forecooler, leaving 209 — 28 or 181 B.t.u. to be absorbed in the tank per pound of ice made. The 475 B.t.u. net refrigerating effect available will then produce 475 ÷ 181 = 2.62 lb. of ice. Now there will be 38 × 2.62 = 99.5 B.t.u. absorbed in the water forecooler. The net refrigerating effect of liquid ammonia at 35 lb. gage is 552 — (137 — 66) = 481 B.t.u.; hence 99.5 ÷ 481 = 0.21 lb. liquid ammonia will be evaporated in the water forecooler.

The total liquid ammonia used for each 2.62 lb. of ice produced will then be: To forecool can water, 0.21 lb; to forecool liquid ammonia, 0.129 lb., and evaporated in the tank, 0.871 lb., a total of 1.21 pounds.

The total vapor at 35 lb. gage will be 0.21 plus 0.129 = 0.339 lb. This amounts to only 0.339 ÷ 1.21 = 28 per cent of the total. On the other hand, Mr. MacNeill states that the compressor will have its capacity increased by 58 per cent. This means that 0.58 ÷ 1.58 = 36.7 per cent of the ammonia handled will have to be produced at the higher suction pressure. This we see will not be the case in the average plant, and this fact would prevent the realization in practice of the 18 per cent saving in power that he shows. In other words, it would seem that he has assumed a higher supercharging pressure than would prevail in practice, and has thus been led to overestimate the possible economies.

Another of his points with which I fail to agree is his statement that a pound of the liquid ammonia under the precooling arrangement will make 14.5 per cent more ice than a pound without precooling. It is hard to see how one can stretch the refrigerating capacity of one pound of liquid ammonia to this extent. Now the heat of the liquid at 150 lb. gage is 137 B.t.u., that at 15 lb. gage is 42, and the latent heat at the lower pressure is 569.6 B.t.u. Hence, without precooling, the net refrigerating effect available per pound of liquid would be 569.6 — (137 — 42), or 474.6 B.t.u.

I have shown that a pound of liquid ammonia passed through the precooler would leave only 0.871 lb. to evaporate in the tank, which would in turn have a net refrigerating effect of approximately 475 B.t.u. per pound of total ammonia handled. We see that the net refrigerating capacity per pound of total ammonia handled is practically the same in each case. Even if all the refrigeration could be done at 35 lb. gage, the net refrigerating effect available per pound of ammonia handled would be only 552 — (137 — 66), or 481 B.t.u. We must conclude that no appreciable gain in refrigerating effect per pound of liquid ammonia can rightly be claimed in figuring the economies due to precooling.

It is evident from a study of the indicator diagrams in the original article that the mean effective pressure in the supercharged cylinder will be about 40 per cent greater than for the normal 15 lb. suction pressure. We must remember that the mean effective pressure for the upper curve must be calculated from the 15-lb. gage line, owing to the fact that this is the pressure that prevails throughout the suction stroke. As the mean effective pressure is to be increased by 40 per cent, one of two things will be true—either the motor has been operating considerably below full load or it will be considerably overloaded.

Another arrangement that will accomplish substantially the same economies as the double-suction pressure plan is to have the high-pressure gas from the ammonia precooler and the water precooler handled by a separate compressor operating at a high-suction pressure.

While with multiple-effect suction the lack of sufficient high-pressure gas to supercharge fully the total cylinder volume will prevent the realization of the maximum economies from this scheme, the plan of using a separate compressor for precooling permits the selection of a compressor of just the proper displacement to give the maximum economy on the precooler.

Another plan that has been successfully employed by me to reduce power consumption, where it is not desired to precool the can water, is to use a small compressor operating at high suction pressure to cool the liquid ammonia in a flash precooler.

In fact, we find that as the suction pressure is increased beyond certain limits the load on the motor driving the small compressor handling the "flash" suction gas actually begins to fall off. This is just what should be expected, for as the suction pressure approaches the head pressure the mean effective pressure becomes less. The exact suction pressure at which the motor load will being to decline will depend on the head pressure carried, but, ordinarily, will be found to lie between 40 and 55 lb. gage.

M. F. KNOY.

Lake Charles, La.

What's New in Plant Equipment

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING TRANSMITTING AND APPLYING THE POWER SERVICES

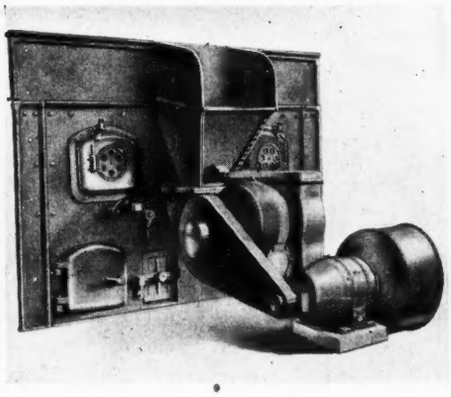


Fig. 1—Front view of stoker, showing enclosed drive

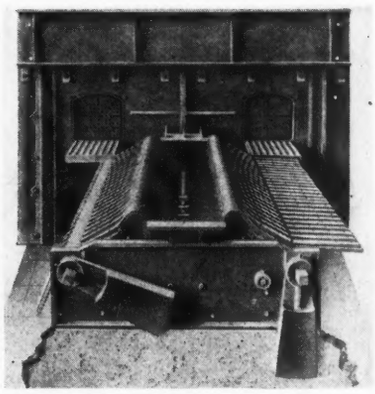


Fig. 2—Dump plates have counter-balance weights

Multi-Zone Underfeed Stoker for Small Boilers

AN UNDERFEED stoker (designated Type SR) of the multi-zone type, especially adapted for burning coking and non-coking bituminous coals and suitable for use with boilers ranging from 500 to 3,000 sq.ft. of heating surface has been added to the line of stokers put out by the McClave-Brooks Company, Scranton, Pa.

Front and rear views of the stoker are shown if Fig.'s 1 and 2 and a sectional side elevation and partial cross-section in Fig. 3. The stoker is fitted with a special single drive in the small sizes and with individual stoker and fan drives in the larger sizes. The driving unit is completely inclosed as shown in Fig. 1.

Coal is fed to the single retort of the stoker by a ram fitted with an adjustable connecting rod, giving a ready means of regulating the amount of coal fed by the plunger. In the retort the coal is disturbed by shoes operated from an extension on the bottom side of the ram. The movement of the shoes is readily adjustable by means of a pin in the pusher rod.

Protection against breakage in the feeding mechanism from foreign matter in the coal is provided by means of a special friction clutch incorporated in the stoker drive.

The grate surface is made up of replaceable tuyere blocks and grate bars. The tuyere blocks are of heavy construction, with staggered mesh to improve the air distribution through the fuel bed. The grate bars, which are located between the tuyere blocks and the dump plates, are of rabbeted design. The dump plates are made sectional and with reinforcing ribs and air space to permit proper burning out of the coal before dumping. The dump plates are equipped with counterbalance weights to facilitate the dumping operation. Fig. 2 is a view of the stoker with one dump open and the other closed.

To provide flexibility in the operation of the stoker and a means of burning the fuel at different rates at different sections of the grate special dampers are arranged to zone the air to the retort tuyeres, grate bars and dump plates as required for proper combustion and the burning out of the carbon in the refuse.

The stoker is fitted with a special sectional expansion cast-iron front, and sectional retort arch plates are used to support the front wall of the setting.

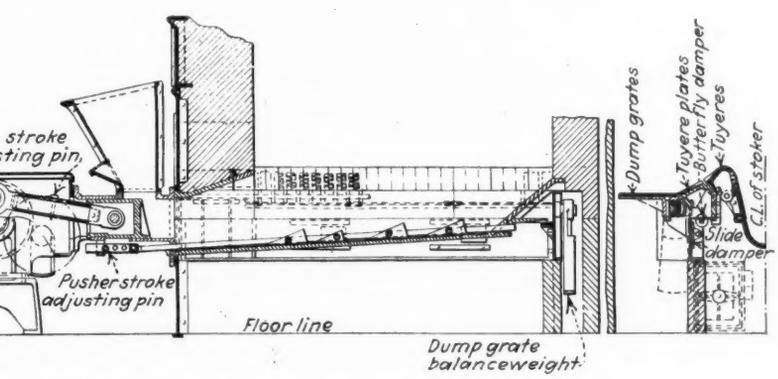
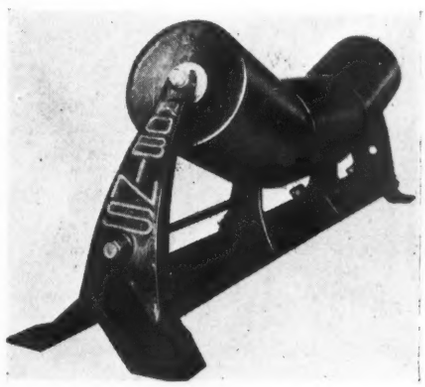


Fig. 3—Sectional elevation and partial cross-section of stoker



Idler with demountable pulleys

Demountable Troughing Idler for Belt Conveyor

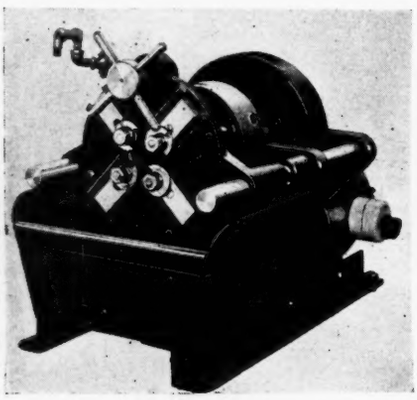
THE troughing idler illustrated, recently brought out by Robins Conveying Belt Company, 15 Park Row, New York City, is similar to the three-pulley roller-bearing idler, made for some years by this company, with the exception that it has demountable pulleys.

The three pulleys with their bearings and grease seals are identical and interchangeable. Each is of cast iron, with totally enclosed ends, and the unit is so designed that each pulley with its shaft of seamless cold-drawn tubing can be lifted out readily from the frame. The side pulleys are set at an angle of 20 deg. from the horizontal and the gap between the pulleys is about $\frac{1}{4}$-in., making it

practically impossible for the belt to be creased at this point.

Adjustment of the roller bearing when assembling the idler is made by a threaded sleeve on the end of the shaft. Subsequent wear on rollers or races is taken up by a coil spring that presses against the inner race. The brackets between the pulleys and at the ends of the idlers are of malleable iron. They are bolted to a structural steel angle base arranged to be self cleaning, so that dirt cannot accumulate under the center pulley.

Lubrication of the bearings in each pulley is by means of grease forced through a high-pressure fitting to a reservoir in the hub of the pulley. All fittings are located at the ends of the idler, where they can be served without reaching under the belt. Protection of each bearing against the loss of grease or the entering of grit or moisture is provided by a double labyrinth seal and a wide felt washer. Standard sizes range from 18 to 60 in. in width.



Bench-type power pipe machine

Improved Cutting and Threading Machine for Small Pipe

THE ½- to 2-in. bench type portable power pipe machine illustrated is fitted with a specially designed cutting head with four blades cutting simultaneously, and the design is such that the die heads are more easily changed from one size to another than in the former models.

The machine is driven by a universal ball-bearing motor and a safety friction gear is incorporated in the drive to protect the motor against overloads. Another feature of the design is that there are no levers to change or gears to shift, as all the control is centralized in the motor switch. The machine is put out by the Toledo Pipe Threading Machine Company, Toledo, Ohio.

A Live or Dead Indicator for High Voltage Conductors

TO PROVIDE a ready and safe means of determining whether conductors above 2,300 volts are alive

How the Glowtector is used

or dead, the W. S. Wilson Corporation, 123 Varick St., New York City, has introduced a device designated the "Glowtector," shown in the accompanying illustration.

The indicator is a rare gas tube fitted in a bakelite assembly. When the assembly is applied to a live line or bus the tube glows. A hood shields the tube from the outside light, permitting it to be used in brightly lighted rooms or sunlight. A three-foot extension stick permits the operator to stand at a distance from the conductor and also to reach out of the way lines.

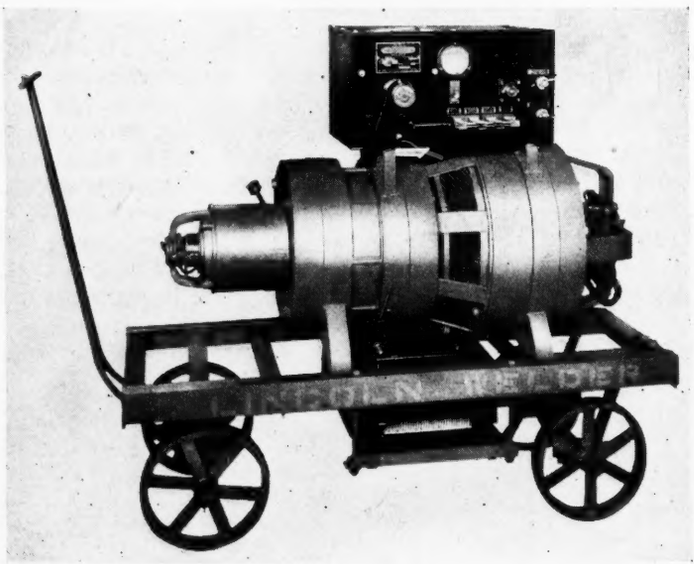
On voltages from 2,300 to 6,600 the glowtector is brought in contact with the bare conductor. On voltages above 6,600 it can be used on insulated lines, with the exception of those that are lead covered. On extremely high tension lines it is only necessary to bring the indicator into the field. It is claimed by the manufacturer that it is impossible to bypass the tube and give a false indication. The "Glowtector" with extension stick measures four feet and weighs two and one-half pounds.

Improved Welder With Unified Control

THE unification of the controls of both motor and generator is an important feature of the improved "Stable-Arc" welder, recently announced by the Lincoln Electric Company, Cleveland, Ohio. The working mechanism of all controls is contained in a ventilated enclosed steel cabinet with hand regulators and switches mounted on a panel that forms a side of the cabinet. The control panel contains rheostat regulator, diverter switch, safety starter switch, volt-ammeter and wing nut terminals for the cables. The control cabinet is mounted directly over the motor generator.

The use of a combined voltmeter and ammeter makes possible the reading of voltage and amperage on one dial and eliminates the use of the separate instruments.

A safety push button switch is incorporated in the control panel for starting and stopping of the welder. This switch makes it impossible to accidentally start the welder.



Welder mounted on truck

Instrument is connected to thermocouple by flexible leads

Pyrometer for Temperatures Up to 1,200 Degrees

A TYPE of pyrometer designed especially for checking the temperature of molten white metals and other similar services is illustrated. The instrument consists of a D'Arsonval-type milli-voltmeter connected by suitable leads to a thermocouple mounted in a special casing. The instrument is calibrated to read temperatures from 0 to 1,200 deg. F., in 20-deg. divisions. It is compensated automatically for changes in temperature and cold end differences by means of a thermostatically operated magnetic shunt operating on the instrument magnet. Clamps suitable for mounting the instrument on a vertical pipe or conduit are provided. A section of armored tubing is built into the couple, protecting the instrument leads up to the point where they are attached to the instrument terminals.

The instrument is put out by the Roller-Smith Company, 233 Broadway, New York.

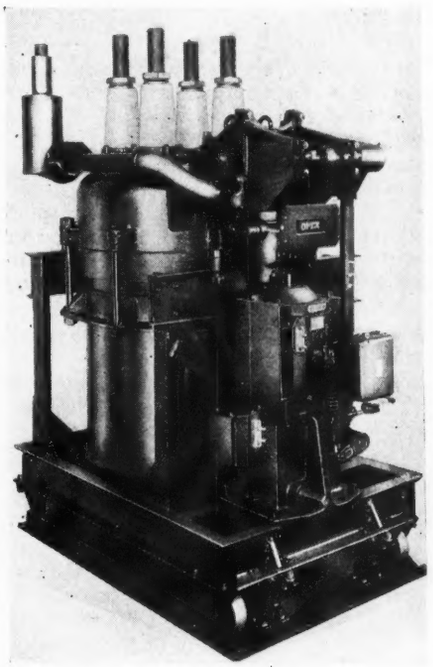
Heavy-Duty Track-Type Oil Circuit Breaker

A NEW line of heavy-duty truck-type oil circuit breakers (type F-120-15 D) for 4,000 amp. on 15,000 volt service is announced by the Condit Electrical Manufacturing Corporation, Boston, Mass.

The contact system, studs, bushings and mechanism are supported by a dome-shaped, cast-steel top, which in turn is supported by a channel and angle-iron structure on wheels. The tank is of boiler-plate steel, cylindrical in shape with rounded bottom supported from the frame.

To afford the necessary current capacity without undue heating, four studs per each pole unit are used, each with a capacity of 2,000 amp. Inside the breaker these studs are clamped in a pair of heavy contact blocks, two studs to each block. From each block extend three inverted laminated bushes, which make contact with a single bridging member of heavy copper.

Eight heavy cylindrical blocks of copper afford such thermal absorption capacity as to materially reduce arcing on interruption. Four series breaks are used, further reducing the duration of arcing. The design of the arcing contact circuit makes use of the electro-magnetic forces developed



Assembly of heavy-duty breaker

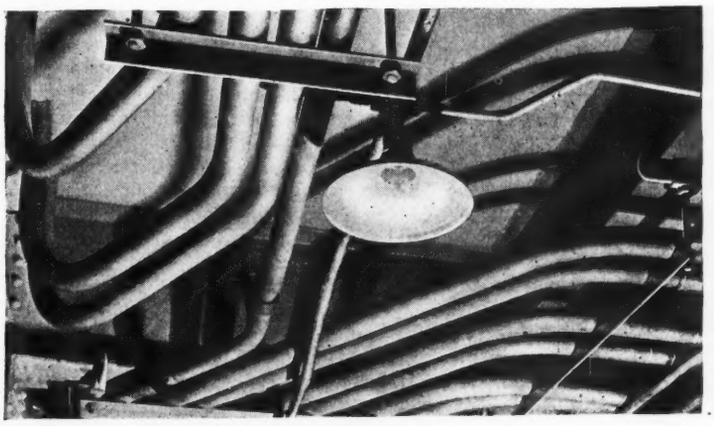
on high current rushes to insure the arcing contacts remaining closed until the brushes have safely parted. The breaker has an estimated interrupting capacity of 1,000,000 kva. at 15,000 volts.

Aluminum Rigid Conduit

THE introduction of aluminum rigid conduit that is light in weight and highly resistant to corrosion is announced by the Aluminum Company of America, Pittsburgh, Pa. The conduit, which has been fully approved by the National Board of Fire Underwriters, has characteristics which make it superior to steel conduit for many purposes. It is particularly adapted for all electrical work in salt-water districts and where electrical installations are subject to attack from certain chemicals and their vapors. It is also claimed that it will not streak or stain the surface of the structure on which it is placed. This quality and because it resists corrosion under all atmospheric conditions makes it especially suitable for use on flood-lighting systems in connection with exterior illumination.

The electrical properties of aluminum are such as to warrant its use for conduit. The conductivity is greater than that of steel, so that under the same conditions it provides adequate grounding connection through the conduit system. Because of its non-inductive properties, it may be advantageously used for generator and transformer leads, lightning arrester connections, and all alternating-current conductors.

The conduit is made from drawn seamless tubing of an aluminum-manganese alloy. This alloy has mechanical properties higher than those of commercially pure aluminum but with equal resistance to corrosion. It is produced in standard iron-pipe sizes, and its dimensions are identical with those of steel conduit. It is furnished in ten-foot lengths, and is enameled inside to comform with standard practice. On applications requiring seamless or jointless runs lengths up to 40 ft. can be furnished upon specification.



Aluminum conduit is readily bent to any desired angle

FROM AMONG THE READERS'

Conducted
By
L. H. Morrison

Adding a Synchronous Motor to an Induction Motor Load—*We have a load of induction motors supplied from a 150-kva. bank of transformers. The load reaches a maximum of about 140 kva., at which time the power factor is about 0.60. If a 50-hp. 0.80 leading power factor synchronous motor is added what will be the load on the transformers?* A. C. R.

On account of the better load power factor obtained by the addition of the synchronous motor, the total load on the transformers will be increased about 10 kva. only. This increase is obtained by assuming that the synchronous motor when fully loaded takes 50 kva. at 0.80 power factor leading. Under these conditions the transformers will be operating at nearly full load, 150 kva. The power factor of the load, after adding the synchronous motor will be about 0.83.

This is a good example of the benefits that may be obtained by correcting the power factor under certain conditions. If a 50-hp. induction-motor load had been added, the load increase on the transformers would have been approximately 50 kva. This would have caused about 20 per cent overload and would probably have required additional transformer capacity to carry the load. If the synchronous motor is installed, the transformers can supply the load. In addition, improving the power factor makes better operating conditions all along the line. When power is purchased, improving the power factor may result in a reduction in the rate.

Ropes on Traction Elevator Become Slack—*On a six-rope, full-wrap traction elevator, 23-story rise, the three front and the three rear cables at the car crosshead will alternately be slack with the car at the top and bottom of the hoistway. That is, if the front cables are taut, the rear cables will be loose when the car is at the bottom, and vice versa at the top. It seems to me that a twist in the cables is the cause of this condition, as this happens on only one of the cars.* A. P.

The cause of this change in tension in the hoisting cables is probably unequal tread diameter of the sheave grooves. When the car is in the down motion the three grooves of the largest tread diameter deliver their hoisting cables to the car side of the sheave faster than to the other three grooves. This causes the cables running in the groove with the largest tread diameter to become slack on the car side when the car is in the down motion. For the same reason, when the car is in the up motion the rope, running in the grooves with the largest tread diameter, will be taut. This difficulty can be corrected by turning all the grooves in the sheaves to the same tread diameter.

Testing Parallelism of Engine Guides—*Without removing the piston, piston rod or crosshead, how can a test be made to determine whether the guides of a horizontal engine are parallel with the center of bore of the cylinder?* P. G.

The center line of an engine cylinder usually is considered to be the line passing through the centers of the counterbores. However, if it is desired to make comparison of the guides with the center of the bore, it would be well to assume the center line of the bore to be a line through the centers of the bore at each end of the stroke of the piston. To establish such a center line without stripping the engine of the piston, piston rod or crosshead, remove the cylinder head and place the crank on dead-center away from the cylinder, to bring the piston at the crank end of the stroke. Wedge a wooden rod across the cylinder bore near the piston for holding one end of a light but strong line at the center of the bore, and secure the other end of the line to a stationary object at a distance of about six diameters of the bore beyond the head end. Draw the line as tight as possible and adjust the ends of the line so it will be central with the bore vertically and horizontally at both ends of the stroke of the piston.

Tightly stretch a second line of the same kind from the top of the cylinder, vertically over the first line and parallel to it, by careful measurements and plumbing from one line to the other. Stretch a third line parallel to the first and second lines, over or to one side of the cylinder the full length of the first lines, and beyond the guides, for a reference line. Carefully test the parallelism of the reference line with both the first and second lines, using a distance piece made of a light wooden rod with ordinary pins in each end. If in any case, careful sighting along a line reveals sag, stretch another line a short distance above the sagging line by careful plumbing and, by replumbing, locate a supporting point for the line at about the middle of its span. Fasten to the crosshead a pointer terminating in a V opening that all but touches the reference line and after rechecking all adjustments remove the line and blocked rod from the cylinder. Then to test parallelism of the guides slowly turn the engine over, preferably backward, and observe whether the crosshead carries the pointer uniformly at the same distance from the reference line for the full length of a stroke.

Extreme accuracy is essential to attaining the desired result.

Operating Motors on Reduced Voltage—*I have been told that reducing the voltage on a motor will cause it to burn out. Why does the current not vary according to Ohms law? According to this law the current in a circuit increases and decreases as the voltage.* M. E. W.

Ohms law cannot be applied to motors as to resistance circuits. When dealing with a resistance circuit on direct current the only factor affecting the value of the current in the circuit is the voltage. On a motor the counter electromotive force in the armature or the stator winding must also be considered. This counter voltage may be equal to over 90 per cent of the applied voltage. By loading the motor and causing it to slow down in speed, the counter voltage is reduced and the current taken from the line by the motor is increased. If the motor is overloaded it will take a current in excess of its rating and will be overheated.

Reduced voltage on a motor may cause it to take an excessive current or it may not, depending on the conditions. If the current is kept within the nameplate rating of the motor, it will not be overloaded. At reduced voltage this would mean that the motor is operating at reduced horsepower. Where the motor is driving a constant torque load and the voltage is reduced the current will increase and may cause the motor to overheat. There are many cases on record where low voltage on alternating-current circuits has caused motors to overheat and destroy their windings.

Diesel Plant Specifications—*Is there a standard form of Diesel plant specifications, giving a list of the various auxiliaries needed and their capacities?* K. C.

There can be no standard Diesel specification any more than a standard turbine-plant specification. Each plant stands alone and the engineer must make a study to see what will be needed to obtain the desired results.

Pipe Color Scheme—*Is there any accepted system of painting piping to permit identification of the fluid contained therein?* G. G. C.

The American Engineering Standards Committee has approved a system of pipe coloring that embraces not only the power plant but also the industrial piping. A copy con be obtained from the American Society of Mechanical Engineers, New York City, for 50 cents.

Rubber Hose for Ammonia—*Is it safe to use a rubber hose for the connection between an ammonia drum and the system when charging?* G. S.

Rubber hose has been so used and no ill effects have been noted. But it should not be a permanent connection.

PROBLEMS

ANSWERS

from Our Readers

THE QUESTION

IN LAYING out a waste-heat boiler plant for generating steam at 150 lb., is it better to employ a water-tube or a fire-tube type of boiler?

F. C. H.

ALTHOUGH the question does not state the nature of the service that the installation is to be put to, the problem is very plainly one of a flow of gases and can not be answered without operating data. The frictional resistance to the flow of gases increases so rapidly with increased velocity above the predetermined point that it is doubtful whether the restricted tube area of a fire-tube boiler would pass enough gases to operate the boiler much above builder's rating.

I have had an opportunity to inspect the waste-heat boiler plants of the steel mills of Coatesville, which are all equipped with water-tube boilers. In all of the waste-heat installation it is necessary to provide an induced draft fan, which will consume from 10 to 20 per cent of the power output of the boilers.

EDGAR P. WANNER,
Lancaster, Pa. 732 E. Walnut St.

THE CHOICE between the vertical water-tube and the horizontal fire-tube types, granting many satisfactory and economical installations of both types, narrows down to one of space allotted. With a high head room and somewhat narrow width, the vertical water-tube type of a given size is preferred over the longer but lower horizontal fire-tube. Moreover, in case of tube renewal, however infrequent, additional head room would be required for the vertical water-tube type and additional horizontal space for the fire-tube boiler. Where feed-water after being treated shows a scaly residue, the former is to be preferred on account of its more effective cleaning at a lower cost. In any event, soot blowers should be installed and operated at regular intervals.

GEORGE H. HEINE.
Erie, Pa.

WITH a pressure of 150 lb., either a fire-tube or water-tube boiler could be used, though the water-tube would be somewhat the safer.

Choice of boiler type would depend largely upon the size of the units to be used and upon operating conditions. The fire-tube boiler has the one redeeming feature of cheapness, and for a small plant with a comparatively poor load factor, might be the better investment.

For a large plant with a reasonably good load factor, water-tube boilers would be more satisfactory. In practically all waste-heat installations, dust in the flue gases is present in large quantities; in the cement industry, it is a deciding factor on boiler type. The large gas passages of water-tube boilers are not as easily clogged as are the flues of a fire-tube, and what dust does accumulate can be much more easily removed. Vertical tube boilers are superior to horizontal tube in waste-heat practice, because they do not permit dust to accumulate as quickly. Boilers with parallel tubes are better than those with staggered tubes, since the latter more quickly bridge over with dust.

R. H. SOGARD.

THE earlier installations of waste-heat boilers were generally of the fire-tube type, but in later years the water-tube type has gained favor especially for larger installations. In many cases where the fire-tube boiler is employed, departure is made from the conventional design in order to provide for the large volume of low-temperature gas.

Temperatures of waste heat gases vary all the way from 800 deg. to over 2,000 deg., depending upon the industry. Heat transfer depends upon temperature difference and gas velocity. Consequently, where the gas temperature is relatively low a high velocity is necessary. This means unobstructed gas passages in order to keep down the draft loss, a factor that should be kept in sight when choosing the design of boiler. In general, an induced-draft fan will be required and an economizer is often installed after the waste heat boiler where the exhaust gas temperatures are high.

The water tube boiler will be easier to keep clean, but the fire-tube boiler usually will be cheaper to install.

New York City. FRED D. JONES.

IN LAYING OUT a waste-heat boiler plant for generating steam at 150 lb., the choice of either a water-tube or a fire-tube type of boiler depends upon the following factors and the choice will depend upon the local conditions to be satisfied.

A boiler operating normally over a fuel bed absorbs from 60 to 70 per cent of its heat by radiation, whereas when operating on waste-heat gases, the gas temperatures are lower and the absorption by radiation will be but 6 to 7 per cent of total heat absorbed. Therefore, if the radiation component is reduced, the heat absorbed by convection must consequently be increased if the total heat absorbed is to remain unchanged.

With standard designs of water-tube and fire-tube boilers of the same rating, the transfer rate is higher in a water-tube design, but the draft drop is appreciably lower in the fire-tube type. By specially designing a fire-tube boiler, using more, smaller and longer gas passages until the draft drop is increased to the point where it is equal to that of a water-tube boiler, the performance of the two types will be comparable, while there will be approximately one-half or less heating surface in the fire-tube boiler.

The fire-tube boiler will also be more desirable as a general rule, because the waste-heat supply and the steam demand are apt to vary independently, and the fire-tube boiler, due to its heat storage characteristics, will handle input and output fluctuations with more flexibility.

However, where the waste-heat boiler supplied but a small part of the total steam required, or where the waste-heat and the steam demand are constant or proportional, it might work out to be advantageous if a water-tube boiler were used. This would be true especially if the other boilers in the plant were of the water-tube design, or if this unit were to be designed with a grate for operation when waste-heat was not available.

R. S. LANE,
Assistant Mechanical Engineer,
Interborough Rapid Transit Company.
New York City, N. Y.

A Question For Our Readers

IS OIL at $1.40 a barrel a cheaper fuel than anthracite buckwheat at $6.60? L. L. P.

Suitable answers from readers will be paid for and published in the Aug. 13 issue.

High Pressures Lead to
District Heating by Power Plants

IN A PAPER before the National District Heating Association at Detroit on June 12, A. A. Potter, dean of engineering, Purdue University, showed how thermodynamic calculations might be used advantageously in predicting the results to be secured by

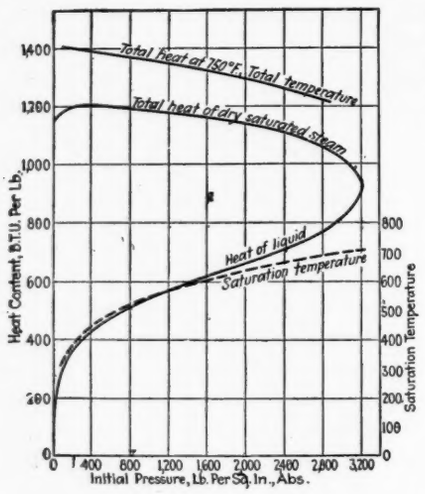

Total heat at 750°F. Total temperature
Total heat of dry saturated steam
Heat of liquid
Saturation Temperature
Heat Content, B.T.U. Per Lb.
Saturation Temperature
Initial Pressure, Lb. Per Sq. In., Abs.

Fig. 1—Properties of steam

taking advantage of the higher steam pressures and temperatures and of the new steam cycles in use in central stations and industrial plants. A review of steam properties led up to the pres-

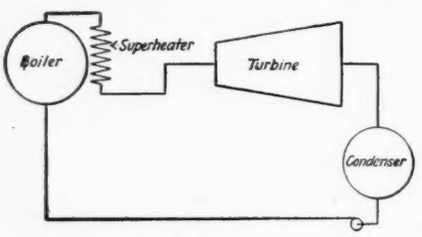


Fig. 2—Rankine cycle

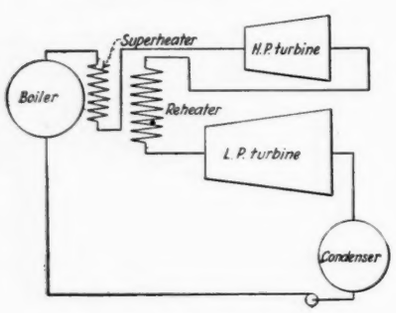


Fig. 3—Reheating cycle

entation of Fig. 1, giving the properties of steam for pressures up to 3,200 pounds.

In discussing steam cycles, the author stated that the Rankine cycles, Fig. 2, had been used until recently as the standard for comparing prime movers, but added that it was practical only for plants that did not reheat or extract steam.

In this type of cycle, steam is generated and superheated at constant pressure, expanded adiabatically (without friction, throttling or radiation losses) to the exhaust pressure, where it is condensed at constant pressure, the condensed steam being returned to the boiler at the condenser temperature.

In the reheating cycle, Fig. 3, steam

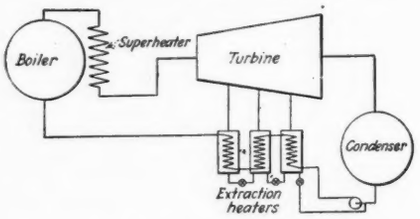


Fig. 4—Regenerative cycle

is generated and superheated at constant pressure, expanded in a turbine to a lower pressure, at which it is withdrawn from the turbine and reheated at constant pressure; it is then expanded to the back pressure and condensed. The reheating cycle has a slightly higher efficiency than the Rankine cycle, on account of the fact that the heat

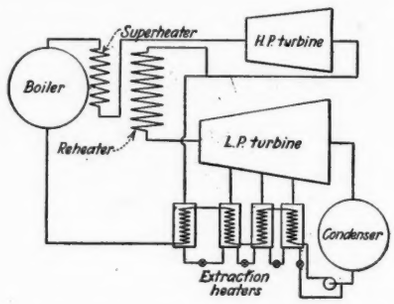


Fig. 5—Reheating-regenerative cycle

added at a high temperature to reheat is used to better advantage than the same amount added during the water-heating stage. Another advantage is the drier exhaust steam, which results in smaller friction losses in the lower stages of the steam turbine.

In both the Rankine and reheating cycles a large portion of the heat of the

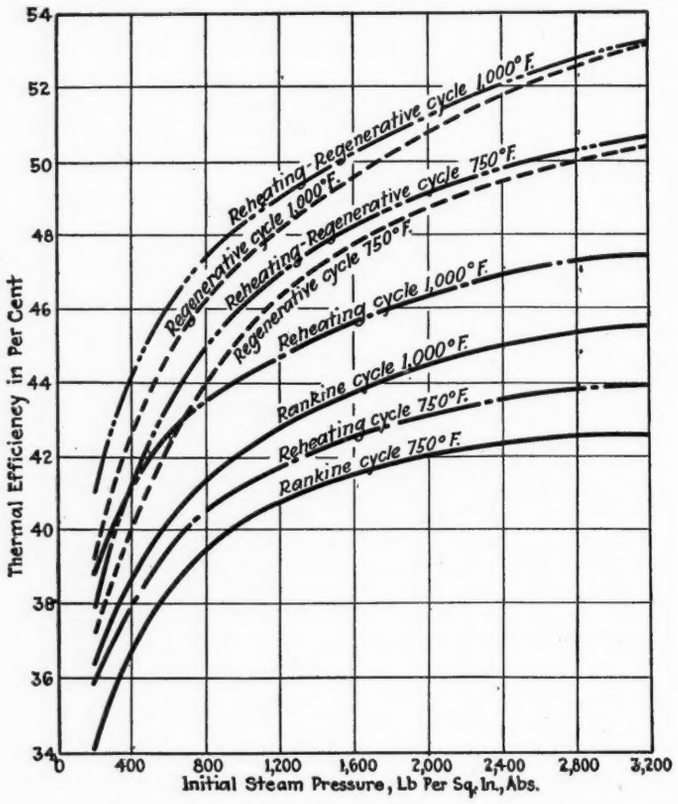


Fig. 6—Thermal efficiencies of steam cycles
(Corrected for work of feed pump. Regenerative and regenerative-reheating cycles based on the use of four extraction heaters. Back pressure 1 in. mercury, abs.)

steam is lost in the circulating water of the condenser. To save a portion of this heat the regenerative cycle, Fig. 4, is used. In this cycle steam is bled or extracted at one or more points while being expanded in the turbine. This extracted steam is used to heat feed water. From two to four extraction heaters are used, depending upon the load factor of the plant. The regenerative-reheating cycle, illustrated in Fig. 5, is a combination of the cycles illustrated in Figs. 3 and 4.

Relative efficiencies at different pressures of these four cycles, with steam at temperatures of 750 and 1,000 deg. F., are illustrated in Fig. 6. From this diagram it is evident that in the case of the Rankine cycle great gain in efficiency may be expected from a pressure increase up to 1,200 lb., considerable gain from 1,200 to 2,400 lb. and little gain above that pressure. The reheating cycle shows higher efficiencies than the Rankine cycle for higher pressures, the regenerative cycle being still more advantageous for high-pressure steam.

In the district-heating industry in the United States the trend has been to increase the pressures of distribution. Pressures as high as 275 lb. per sq.in. are used. The advantages of having one plant manufacture steam for heating as well as for supplying electricity are evident, as the load factor of the heating plant is low, 20 per cent being considered good and 25 per cent about the maximum. To show that it is practical to extract large quantities of steam from turbines while utilizing high pressures and the newer cycles, Fig. 7 is presented to indicate the available

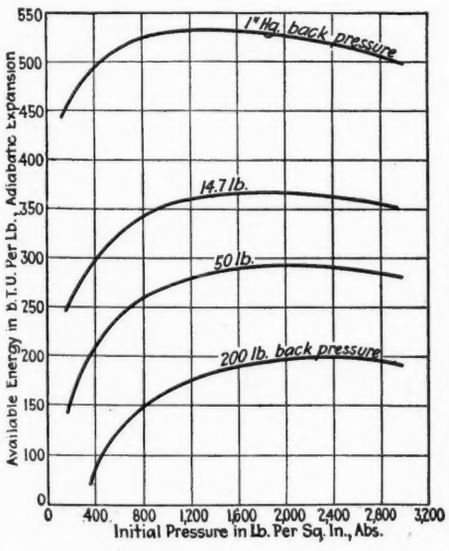


Fig. 7—Heat available for conversion into work

energy, or the heat that can be transformed into work when one pound of steam is expanded from initial absolute pressures of 200 to 3,200 and with final absolute pressures of 200, 50, 14.7 and 1 in. of mercury. Fig. 8 shows the theoretical steam consumption of an ideal prime mover operating on the Rankine cycle when steam is expanded under the same conditions as in Fig. 7.

Both charts illustrate the advantage of pressures as high as 1,200 lb. if high back-pressure steam is to be utilized for heating or other purposes. Thus, it is possible to secure as good a steam consumption with 50 lb. exhaust pressure and 1,400 lb. initial as could be obtained with atmospheric, if the initial steam pressure were only 300 lb. per sq.in. Again, if the initial steam pressure were 2,000 lb., a pound of steam, if expanded to atmospheric pressure would have nearly three-fourths the heat available for conversion into work, as compared with steam at 400 lb. that was expanded to 29 in. of vacuum.

Fig. 9 is used to illustrate the heat content in exhaust steam for initial pressures varying from 200 to 3,200 lb. and 750 deg. F. and adiabatic expan-

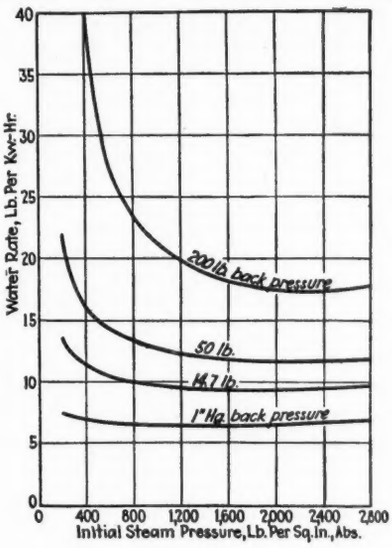


Fig. 8—Theoretical water rate
(3,415 ÷ Available energy, B.t.u. per lb.)

sions to 200, 50, 14.7 and 29 in. vacuum. This diagram shows that steam, if expanded from 400 to 50 lb. absolute has about the same heat content in the exhaust as dry steam generated at 50 lb. Also steam expanded from 1,200 lb. to 200 has nearly as much heat in the exhaust as dry steam generated at 200 lb.

From the foregoing it is evident that in power plants utilizing high-pressure steam thermodynamic considerations justify, in conjunction with electric power generation, the supplying of steam for district heating. Such a high-pressure power plant might be operated non-condensing during the heating season or, preferably, bleeder turbines could be used and steam extracted for heating at practical pressures for different seasons.

Industrial power plants are being designed, to an increasing degree, not only to manufacture steam for heating and for process work, but also for the generation of electric power as a by-product of high-pressure steam generation. Suggestions have been made that high-pressure industrial power plants and electric central stations should pool their product. However, this is feasible only in special cases. In many localities the electric central stations would do well to consider the generation of steam for district heating as well as for power production. If cen-

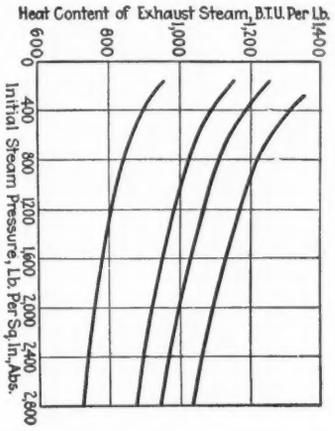


Fig. 9—Heat content of exhaust steam
(Assuming adiabatic expansion from initial pressure to back pressures of 200, 50 and 14.7 lb. and 1 in. mercury)

Pressure, Lb.	B.t.u. Content of Dry Saturated Steam
200	1,198.5
50	1,175.6
14.7	1,151.7
1 in. hg.	1,096.4

tral stations can manufacture electricity cheaper than industrial plants, will not the use of higher-pressure steam enable them also to compete with industrial plants in the sale of steam as well as power?

Practical considerations such as synchronism of heating and electric load factors, cost of fuel and distribution problems would determine, finally, the financial success of combining electric and district-heating functions in one power plant.

Trend to Elaborate Instrument Sets Noted by N.E.L.A. Group

WITHIN the past decade there has been a decided change in the attitude of both designing and operating engineers toward the use of station instruments," says a report of the N.E.L.A. prime movers committee. Formerly such instruments, especially those for boiler and turbine operation, were expensive both in first cost and in maintenance, and were unreliable in their results. Moreover, when boilers seldom exceeded 7,000 sq.ft. of heating surface, and the turbines were small, the cost of the instrument was a large proportion of the total cost of the installation.

The committee has found that boiler and turbine room instruments show marked improvements in accuracy, reliability and decreased maintenance. With the increasing size of boiler units, the cost of instrument installation has become a small part of the total cost. The intelligent use of instruments has fully justified these expenditures, according to the report.

Some Things One Should Know

About Workmen's Compensation Laws

By Leo T. Parker
Attorney at Law, Cincinnati, Ohio

Some fundamental decisions and interpretations by the courts that have as much bearing upon injuries sustained around a power plant as in any manufacturing establishment. All those in responsible charge of power plants as well as the owners should be well informed on these legal points.

ALMOST all states have adopted laws requiring proprietors who employ several persons or more to perform certain duties, such as filing specific reports with the state, giving information of the number of their regular employees, the duties of such employees, wages earned by them; and in many instances the employers are required to contribute to a fund set aside for compulsory payment of compensation to injured employees.

It is important to know that employers should carefully comply with these statutes, since failure to do so may result in greatly increased liability. This is true because the courts have consistently held that an employer, who fails to comply with workmen's compensation laws, not only is subjected to payment of heavy penalties, but also automatically becomes liable in damages for all injuries sustained by employees, irrespective of the provisions of these laws which, under ordinary circumstances, may reduce the common law liability.

Violation of Compensation Laws Increases Liability

While it is true that under the common law an employer is not liable for injuries sustained by an employee as a result of the latter's own negligence, generally, the employer who fails to abide by the state compensation laws is not permitted to avoid liability on the common law defense.

For illustration, in Holton vs. Clayco Company, 145 S. E. 637, an employee who negligently injured himself, sued his employer for damages. The latter attempted to avoid liability, but the employee introduced testimony showing that the employer had failed to abide by the state compensation laws. In view of this evidence the court held the employer liable, and said:

"When an employer comes within the purview of the workmen's compensation and is not protected by it, and a suit is brought against him for an injury occurring to one of his workmen, received in the course of his employment and arising out of it, he (employer) cannot interpose as a defense assumption of risks, or negligence and carelessness on the part of the workman, where the employer has been negligent himself, and from which negligence the injury resulted."

Distinction Between Common Law and Statutory Liability

There are many circumstances under the common law where an employer is not liable in damages for injuries sustained by employees, whereas for the same kind of injuries the workmen's compensation laws authorize payment of compensation.

For instance, under the common law an employer is not responsible for injuries that a workman inflicts purposely or accidentally on his fellow-workman. However, under the workmen's compensation laws the injured employee is entitled to a specified amount depending upon the character and severity of the injury, irrespective of the cause, provided the injury was sustained while the employee was acting within the scope of the employment.

On the other hand, injured employees sometimes prefer to sue for damages under the common law rather than accept the amount of compensation fixed by workmen's compensation laws. This circumstance may exist where the injury resulted from *negligence* on the part of the employer, and the employee believes that a jury will allow a verdict for damages for an amount greater than the compensation authorized by the compensation laws.

However, an employee who elects to file suit under the common law is barred from relying upon the workmen's compensation laws to obtain positive payment, should the suit terminate adversely for him.

Courts Follow Statutes Strictly

In deciding litigations involving injuries to employees under the compensation laws, the courts are governed strictly by the exact terms of the statutes.

For example, in Montello Co. vs. Schultz, 222 N. W. 315, it was disclosed that an employee who was injured while performing his regular duties, failed to give his employer written notice of the injury, as required by the compensation laws. The counsel for the employee argued that since the employer had definite information of the injury, a written notice was not necessary. However, the court held the employee not entitled to compensation, saying:

"The Workmen's Compensation Act is statutory in its origin, and whatever rights employees have in regard to compensation accrue solely by virtue and under the provisions of the statute. . . . As a part of this statutory scheme the employee is required to give notice of his disability. The period of such notice is limited in order to enable the employer to determine whether the claim is a bona fide one, and to afford him an opportunity to examine into the facts concerning the injury, and the extent of such injury, and all other necessary facts involved in a compensation claim."

Relation of Employer and Employee Must Exist

Generally speaking, an employer is not liable under either the common law or the compensation laws, for injuries sustained by any person unless the party claiming compensation proves to the satisfaction of the court that when the injury occurred, he was actually in the employ of the party being sued.

Whether the relation of employer and employee existed at the time of the injury, depends upon the answer to the question: Was there an *express* contract, *or do the acts* show that the parties recognize one as the employer and the other as the employee?

While the question whether a person performing work for another is a legal employee is one not always easy of solution, yet the courts are in accord with the rule that the right of the employer to control the employee indicates the relation of employer and employee.

Also, the law presumes that where one person is employed to work on the premises of another to accomplish a benefit for the latter, the workman is a legal servant. If the employer seeks to avoid liability for the employee's acts on the ground that he was not a servant, the burden is upon the employer to establish that fact.

However, the fact that an employer pays a person at regular intervals does not indicate *conclusively* that he is an employee. Circumstances may exist under which a person receives payment for performing work, when in fact, he is not legally an employee. For example, a person who performs a special service for a stated compensation and is permitted to perform the work in accordance with his own ideas, is an "independent contractor," who is not entitled to compensation from the party for whom he is performing work.

In many litigations involving the liability of employers for damages as a result of injuries sustained by employees, the outcome of the controversy is dependent upon whether or not the employee was acting within the scope of the employment when the accident occurred. In many instances persons confuse the terms "within the scope of the employment" and "in the service of the employer." However, it is important to know that an employee who is injured "while serving his employer," may not be "acting within the scope of the employment" when the injury is sustained. Under the former circumstance the employee may or may not be entitled to compensation, but he always is entitled to compensation for an injury sustained, *as a result of the negligence* of his employer, while working within the scope of the employment.

However, the law is well settled that an injury arises out of an employment *when it occurs in the course of the employment and is the result of a risk involved in the employment or incident to it.*

Distinction Between "In Course of Employment" and "Out of" Employment

Sometimes litigation arises when an employee is injured while attending to personal duties or necessities such as getting a drink of water, attending to bodily necessities, or the injury is sustained during rest periods, or at other times when the employees is not actually rendering a service for his employer, but is performing acts incidental with the employment.

Generally, the employee is entitled to compensation under the compensation laws for such injuries. In other words, an accident arises "in the course of the employment" if it occurs while the employee is doing what a man so employed may reasonably do during the hours of his employment, and at a place where he may have good reason to be during that time. Moreover, an injury arises "out of" the employment when the risk may have been contemplated by a reasonably prudent person when entering the employment.

Sometimes, the courts have considerable difficulty in determining whether an employee is entitled to compensation, under the workmen's compensation laws, when he is injured while attending to his regular duties, but under circumstances *not* connected with the employment. For instance, in the leading case of Carmichael vs. J. C. Mahan Co., 11 S. W. (2d) 672, decided during the past few months, an employee, who was attending to his regular work, was shot in the eye by a boy who was playing with an air rifle.

The lower court held the employee not entitled to recover compensation, but the higher court reversed this verdict and in holding the employer liable, said:

"It is said an injury arises out of the employment when there is apparent to the rational mind, upon consideration of all the circumstances, a causal connection between the conditions under which the work is required to be performed and the resulting injury. . . . The employee, while at his post of duty, going about his employer's business, was struck by a missile from an air rifle in the hands of children, guests of the employer, who were impliedly invited to the premises and permitted to remain there."

In other instances, the question has arisen whether an injured employee is entitled to compensation for an injury sustained while the employee is attending to his regular duties outside the state in which his employer's plant is located.

For example, in Hargis vs. McWilliams Co., 119 So. 88, an employer in Louisiana sent an employee outside the state to perform a service. While attending to the work, the employee was injured. The employer contended that he was not liable under the Louisiana laws for an injury sustained by the employee who worked in a different state. However, the court held the employee entitled to payment of compensation in this case.

Exhaust-Gas Turbine-Driven Supercharger for Diesel Engines

THE Swiss Locomotive & Machine Company, in collaboration with Brown, Boveri & Company, has developed a new type of oil engine for moderate and higher capacities. This engine is super-charged by means of a Buechi turbine compressor, which delivers the combustion air into the cylinders under slight compression. This makes possible the burning of a correspondingly greater amount of fuel within the cylinder without appreciably increasing the temperature.

With the working cycle introduced by the builders and other improvements, consisting of a special exhausting and scavenging system for each cylinder, the engine capacity was increased well beyond the expected.

By compressing the combustion air to 1.3 atmospheres before introduction into the working cylinder, it is feasible to increase the output of any Diesel engine by 50 per cent, without exceeding the present maximum pressure or producing greater bearing pressures.

As the engine output increases, a larger quantity of exhaust gas is delivered to the turbine driving the compressor, which in turn delivers more air to the cylinders. The combustion efficiency and proper scavenging are, therefore, automatically maintained. The supercharger enables any Diesel engine to operate with a flexibility comparing favorably with that of a steam engine or turbine. The engine can carry a 20 per cent overload for several hours and from 35 to 45 per cent overload for periods of short duration, with unimpaired combustion efficiency, according to A. Buechi, in *Die Warme*.

No radical changes in existing engines are necessary to adapt them to supercharging. The principal alterations consist in providing the necessary connections to the intake and exhaust manifolds. Also, it is desirable to provide the valve spindles with spring sealing rings and cooled guides to prevent leakage of combustion air and exhaust gas.

The operation of the Buechi supercharger presents no difficulties. A turbine governor is supplied only in special cases, where the load fluctuations are unusually severe, for usually the turbine speed varies with the weight of the exhaust gas.

Supercharging does not improve the economy of medium-sized engines, but does show a decided gain in the larger units, due principally to the more efficient operation of the large compressor.

Reliability in service is unaffected by the supercharger. If the compressor should go out of service, the engine could continue to operate with atmospheric intake, but at a reduced working pressure. This is not the case with engines to which the combustion air is supplied by special pumps, or with two-cylinder engines, in which failure of the scavenging air pump must result in immediate shutdown.

Supercharging does not increase the cylinder, piston or valve temperatures, even with the higher output, and for this reason no additional cooling water is necessary. The engine can be more compact and weighs approximately 70 per cent as much as the ordinary atmospheric-intake engine of the same capacity. Consequently, the first cost should be less, even when the blower is included.

Either new or existing Diesel engines may be equipped in this manner, but care should be taken that the driven equipment is capable of absorbing the increased power supplied.

In the case of marine engines it should be noted that if the same propeller is retained, supercharging will increase the engine r.p.m., and that as a result of this feature, the shaft horsepower will rise as much as 65 to 83 per cent, if the air supply enters at a pressure of 1.5 atmospheres. The speed of the vessel will, therefore, be increased by 18 to 22 per cent. If, on the other hand, it is decided to retain the original engine speed, it will be necessary to install a propeller with a higher pitch, to absorb the normal 50 per cent increase in engine capacity, which will increase the vessel's speed by about 14 per cent.

Events and Men in Power's Field

THE EDITORS WILL WELCOME THE CO-OPERATION OF READERS IN REPORTING INTERESTING HAPPENINGS, PERSONAL OR OTHERWISE

Announce Tentative Plans for World Power Conference

PLANS for the second world power conference, which will be held next June in Berlin, Germany, are gradually taking form. The conference will cover every possible phase of power generation, transmission and utilization. The major classes into which the program will be divided are as follows:

SOURCES OF POWER — Solid fuels, liquid fuels, gaseous fuels, water power, and the utilization of solar energy, heat stored in the earth and wind power.

POWER PRODUCTION, TRANSMISSION AND STORAGE—Steam-power plants and fuels, internal-combustion engines, water power and mechanical transmission of power.

UTILIZATION OF POWER—Agriculture, domestic and industrial uses, transport, mines and metallurgy, buildings and factories.

GENERAL — Distribution of power, power and legislation, technical education problems, stardardization and statistics.

In all fields the articles and discussion will deal principally with economic considerations rather than technical and engineering questions, except where those technical matters are of recent origin. It is planned to give consideration to steam power plants not merely as power producers but from the point of view of power distribution, in which the most important requirement is that the cost of power should be reduced to a minimum through low consumption of fuel and steam, small weight and space required per unit of capacity, at the same time meeting the demand for maximum reliability.

Papers on the economic basis for judging steam turbines; the technical and economic possibilities of mercury and other binary vapor turbines; economic comparison of reciprocating steam engines with turbines; the requirements of plants for heat and power in both industrial and public installations; special studies of plants for extra high pressures; and upon the smoke, soot and gas nuisance are being requested for presentation at the conference.

The use of gas engines for small and large power plants, and data for an economic basis for comparing high-pressure steam turbines with gas-engine plants is one of the many points which will be taken up.

In the field of water power such subjects as experience and progress in matters of water economy and water storage, and new developments in the construction of water turbines and pumps undoubtedly will be developed.

In the section that will deal with electricity, such vital questions as the selection and subdivision of generating plants into large central stations; the technical and economic control of the flow of power in multiple-connected systems; troubles in transmission systems and their removal; problems of remote control; recent applications of electricity to domestic and agricultural fields, and electricity tariff systems will be discussed.

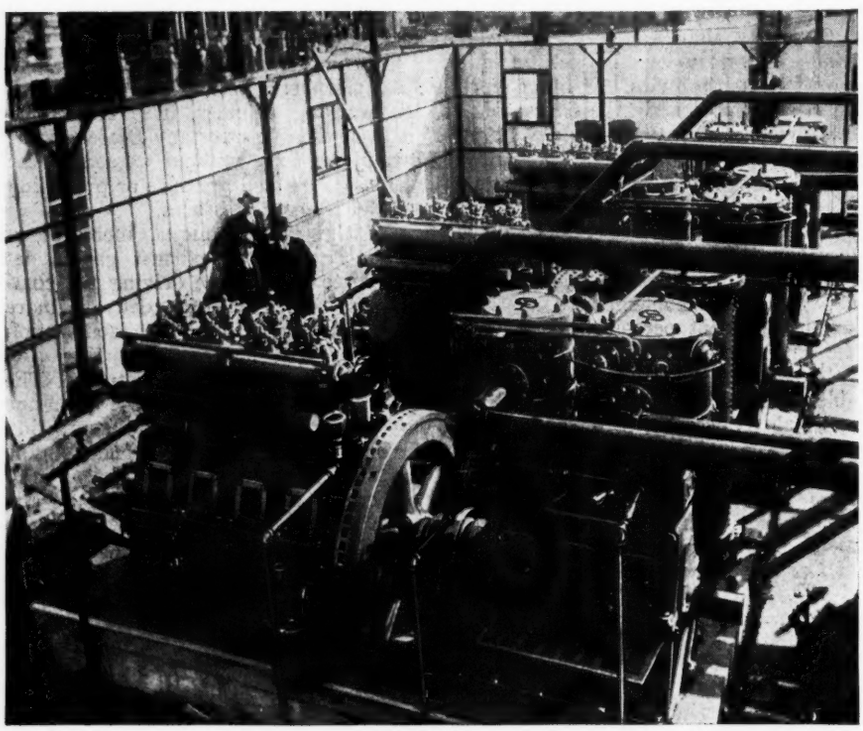
The important question of power and legislation will lead to consideration of the extent and nature of public control and the legal and economic principles that lie behind it.

The report that contains this technical program has been prepared by various subcommittees of the conference management. Detailed memorandum sheets listing material upon which papers are especially desired have been prepared. Additional suggestions are to be submitted to the secretary through the general chairman of the American committee, O. C. Merrill, of the Federal Power Commission, Washington, D. C.

Craftsmen to Hold Annual Convention in Detroit

From Aug. 5 to 9, inclusive, the annual convention and mechanical exposition of the Universal Craftsmen's Council of Engineers will be held in Detroit, Mich. Headquarters for sessions of the convention and the exhibits will be at the Book-Cadillac Hotel. The floor plans are being laid out so that the entire visitation must pass through the exhibit space en route to the convention hall.

One of the outstanding entertainment features of the convention will be an afternoon spent at the Ford air port. Officials of the Stout Air Services, the organization conducting all trips of inspection through the air port, has set aside Wednesday afternoon, Aug. 7, for



THESE 160-hp., CP Diesel engines direct connected to CP vertical air compressors are being used in connection with work on an extension of the Eighth Avenue subway in New York City. Operating without objectionable noise or smoke, this plant is saving sufficient in power cost, as compared to purchased electric power, to pay for itself by the time this one job is completed.

the exclusive use of the Universal Craftsmen's Council of Engineers. Special guides will take the visitors on an educational tour through the entire Ford aircraft plant, where they will witness practically every phase of aeronautical activity. Special arrangements will be made to make available to the visitors a 25-mile aerial tour of Detroit, including a flight over Windsor, Canada, a complete circle of the downtown section of Detroit and a good view of the Ford River Rouge plant.

Two Ships to Take Engineers to World Congress at Tokio

Two vessels have been engaged to transport the American and European delegations to the World Engineering Congress at Tokio, beginning October 30. The European group will go to Tokio via the United States, and it is expected that they will begin to arrive here this month. Many distinguished engineers and scientists from Germany, England, Sweden, Denmark, France, Belgium, and Italy will be in this group. Roy V. Wright, president of the United Engineering Society, will arrange for their reception and entertainment.

The American party, numbering about 250, will leave New York for San Francisco on two special trains. The first, scheduled to depart October 2, will proceed via Washington. They will be received at the White House by President Hoover, honorary chairman of the American Committee, and will attend a reception and dinner given by Katsuje Debuchi, the Japanese Ambassador. The special train will then journey to San Francisco, where it will be met by the second train, which will proceed directly from New York on October 6. Both ships, the S.S. "President Jackson" and the S.S. "Schmyo Maru," will sail at the same time. They will give the delegates a two-day stop-over at Honolulu, arriving in Tokio on October 29.

Human Relations in Industry Lake George Conference Theme

The twelfth annual conference on "Human Relations in Industry," at Silver Bay on Lake George, N. Y., will run this year for four days, the opening session occurring on Wednesday, Aug. 28. This conference, under the auspices of the industrial department of the Y. M. C. A., will be attended by over 600 representatives from all ranks in the industrial world.

Among the major themes that will be developed at the conference are: "Stability of Employment," "The Older Worker's Place in Industry," "Economic Problems and Unemployment," "Larger Conceptions of Safety," "Spiritual Values of Industry," and "Law as a Basis of Industrial and National Progress." A special course in industrial leadership will be held for those interested during the week preceding the conference.

Spot * News

PURCHASE *of the maximum power to be developed by Boulder Dam was guaranteed by representatives of the Los Angeles Bureau of Water and Power, the Southern California Edison Company, Los Angeles Gas & Electric Corporation and the Southern Sierras Power Company in a recent conference with Dr. Elwood Mead, U. S. Commissioner of Reclamation, in Los Angeles.*

* * *

STATISTICS *on inter-industry sales and purchases of mechanical equipment and supplies are to be included in the first national census of distribution to be taken in 1930, if present plans are followed.*

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THE TEMPORARY *state commission created by the New York Legislature of 1929 to study the public service commission law has organized with Senator John Knight as its chairman.*

* * *

CONFLICTING APPLICATIONS *for rights on the Chatahoochee River, near West Point, Ga., will be considered at a public hearing July 16 before the chief engineer of the Federal Power Commission. J. Smith Lanier and the Columbus Electric & Power Company are the contestants.*

* * *

ACCORDING *to reports received by the Bureau of Mines, the production of crude petroleum in the United States during May, 1929, amounted to 84,415,000 barrels, a daily average of 2,723,000 barrels. This constitutes a new high record both for total and daily average.*

* * *

A PERMIT *for the development of White Mud Falls, Manitoba, at which more than 300,000 hp. is available, has been granted the British Dominions Power Company of Canada by the federal government at Ottawa.*

* * *

THE OUTPUT *of electric energy in May, 1929, by the International Paper & Power Company system was 383,347,000 kw.-hr., 34 per cent greater than the production of the system in May, 1928, and a new high record for a single month.*

* * *

THE UTILITIES COMMITTEE *of the Seattle City Council has voted to abandon the plan for $3,000,000 dam at Hanging Rock on the Skagit River and instead will raise the crib dam now serving the Gorge Creek power plant.*

Huge Power Project Planned for Austrian Alps

A tremendous hydro-electric development, large enough to produce about one-third of Germany's total consumption of electric energy, is being planned by the German electrical trust, "A.E.G." In the Hohe Tauern, high in the Austrial Alps, it is proposed to construct a system of underground canals to collect the waters of the various streams. These canals would begin at an elevation of from 9,000 to 10,000 ft. and would have a total drop of about 5,000 ft. The drop will be made in three stages with separate installations at each section. With high-tension transmission at 220,000 volts, it will be possible to send the energy profitably to central, and even to northern, Germany.

The cost of transmission is estimated at only 0.3 pfennig per kilowatt-hour, against 0.4 to 0.6 pfennig on existing systems. Interest charge to cover cost of construction is estimated at 6 to 7 per cent against 15 to 20 per cent for the present power systems in Germany. The result would compare favorably with the best American practice.

Shanghai Plant Sold to U. S. Firm Is Notable Municipal Work

In purchasing the municipal electric plant of the International Settlement at Shanghai, China, the American and Foreign Power Company, of New York City, has not only broken down British control of electric development in China, but has acquired one of the most notable and successful municipal power developments in the world.

Despite the unsettled political and industrial conditions throughout China, the plant has shown constant growth and constantly increasing returns. The financial standing of the undertaking at the close of last year was as follows:

Capital outlay of the undertaking	$23,646,253
Return on total capital outlay	12.72%
Return on capital outlay in use.....	13.82%
Revenue from sale of electricity, etc.	$7,707,962
Gross profit, after depreciation allowance.	$3,008,127
Net profit, after providing for interest on loans, etc.	$1,899,180

Since 1916, the general municipal funds of the International Settlement have participated in the profits of the department, and a total of $5,856,000 has been turned over to the Municipal Council by the electricity committee.

Technical data show the healthy condition of the project fully as much as does the financial report. The installed generating plant capacity in actual service during 1928 was 121,000 kw. Two new 20,000-kw. turbine alternators and four boilers equipped for pulverized-coal firing are practically completed and will probably be in

service this summer. The peak load at the plant has increased steadily year after year. In 1908 the peak load was 2,000 kw.; in 1918 it had increased to 22,000 kw.; and during January, 1929, it was well above 100,000 kw.

The load factor for the development is remarkably high. In 1928 it was 61 per cent. The high load factor stands out when compared to that of the five largest municipal undertakings in Great Britain, which average hardly more than half of this figure, the largest municipal plant in Great Britain, in the City of Manchester, having a load factor of only 33.21 per cent.

The total number of kilowatt-hours sold in 1928 was 458,360,215. This was an increase of 14.49 per cent over the previous year, and more than five times the energy disposed of in 1918. While by far the greatest part of this energy is sold for power uses, the steady growth of the heating and cooking business is interesting. The low rate charged for heating and cooking power is causing a decided increase in the percentage used for this purpose. Heating and cooking now consume 18.5 per cent of the domestic load, and it is believed that it will, in time, surpass the lighting demand. Heating appliances, heaters, cookers, etc., consuming a total of 34,141 kw., are now in use, and the department has recently arranged for hiring to consumers electric water heaters for domestic purposes which will increase this figure considerably.

Formerly, a good percentage of the motors connected were hired out to consumers by the department. Last year there was a decrease in the number of hired motors, but this is taken to indicate increased industrial stability. The aggregate horsepower of power motors connected increased from 108,454 in 1927 to 120,363 at the end of 1928. The fact that the hired motors dropped off merely means that power users are more and more inclined to purchase motors of their own.

The foregoing digest of the financial and industrial condition of the plant, taken from the annual report of the electricity committee of the Municipal Council, appears to justify the action of the American & Foreign Power Company in bidding approximately $50,000,000, more than twice the capital outlay as contained in the report.

Hydro-Electric Plant Under Construction in Washington

A new 37,500-hp. hydro-electric plant on the North River near Aberdeen, Wash., is now under construction. The project, which is being carried out by Sanderson & Porter for the Western Washington Electric Light & Power Company, will cost $3,500,000 and will take a year and a half to complete.

The dam itself will be about 120 ft. high and 400 ft. long and will impound about 270,000 acre-feet of water. The reservoir will have a surface area of 7,600 acres. The plant will have two 12,500-hp. generating units with space for the third unit. About 40 miles of 66,000-volt transmission line will be erected. The company expects to be ready to deliver 25,000-hp. late in 1930.

The Western Washington Electric Light & Power Company is a subsidary of the Federal Light & Traction Company.

Men in the News

EZRA C. BINGHAM,

formerly chief engineer of the Waldorf-Astoria, has been appointed chief engineer of Medical Center, in New York City. For 28 years prior to razing the world-famous hotel, Mr. Bingham had charge of its light, heat, power, ventilating and refrigeration systems as well as its many repair shops. Only once during that time was there a failure of electric light. That was when a newspaper reporter placed a wrench across the mains in order to take a flashlight photograph of President Coolidge. Though he regrets to leave the Waldorf-Astoria, Mr. Bingham is assuming an even more important position as chief engineer of the Medical Center.

Specifications Are Issued for California Power Development

Specifications have been issued by the Pacific Gas & Electric Company, San Francisco, for bids on one 13,500-hp. vertical Francis turbine for 244 ft. maximum static head, and one 11,000-kva. a.c. generator for installation in its Salt Springs power plant; and also for two 36,000-hp., 1,190-ft. effective head double overhung impulse waterwheels, and two 30,000-kva. a.c. generators for its Tiger Creek power plant. These plants will be the first of a chain of four which will comprise the company's Mokelumne River project.

American Engineers' Memorial Committee Appointed.

Carrying out the provisions of the deed of gift of the War Memorial to the University of Louvain, the committee to advise with the University of Louvain in administration of the carillon and clock dedicated on July 4, 1928, to be known as the "American Engineers' Memorial Committee," has been appointed. Its members are: Prof. Etienne Van Cauwenbergh, librarian, University of Louvain, chairman. Julien Liebaert, Minister of State and president of the Hoover Foundation for the Development of the University of Louvain. Millard K. Shaler, American engineer, resident of Belgium. Roy V. Wright, ex-officio, the president of the United Engineering Society.

Standard Symbols Completed; Discussion Invited

The proposed standard "Symbols for Mechanics, Structural Engineering and Testing Materials" have been completed in tentative form by the Subcommittee on Mechanics of the Sectional Committee on Scientific and Engineering Symbols and Abbreviations. The standard symbols, created to avoid the difficulties resulting from confusion of terms in formulas, tables and technical writing in general, are now available in pamphlet form and are being distributed for criticism and comment. Any discussion should be addressed to Prof. J. T. Faig, The American Society of Mechanical Engineers, 29 West 39th Street, New York City.

The report is the work of Subcommittee No. 1 of the Sectional Committee on Scientific and Engineering Symbols and Abbreviations, which has already established standards for mathematical, electrical, aeronautical, and telephone and telegraph symbols. Representatives of 37 national scientific organizations serve on the committee. The American Society for the Advancement of Science, the Society for the Promotion of Engineering Education, the A.I.E.E., A.S.C.E. and A.S.M.E. are joint sponsors.

National Research Council to Aid World's Fair

Formation by the National Research Council of a special committee of scientists from all sections of the United States and covering every field of pure and applied science, who will serve as an advisory body of co-operation with the trustees of "The Century of Progress," Chicago's international exposition to be held in 1933, was announced recently. Simultaneously with making public the names of the group to be known as "The National Research Council Advisory Committee to the Century of Progress," it was stated that scientific progress in industry will be emphasized at the exposition.

Trustees of "The Century of Prog-

ress," of which Rufus C. Dawes is president, called upon the National Research Council as the recognized national scientific organization in the United States to appoint an advisory committee to aid them in the organization of the science features of the exposition. In accordance with this request Dr. George K. Burgess appointed an executive and general advisory committee of scientists, engineers and representatives of scientific societies to co-operate with the exposition trustees. Members of the executive committee are: Dr. Frank B. Jewett, chairman, Gano Dunn, Prof. M. I. Pupin, Dr. William Allen Pusey, Dr. George K. Burgess, Dr. Vernon Kellogg, Dr. Max Mason, and Maurice Holland, executive secretary.

Arc Welding Instruction Is Given by General Electric

A practical course of instruction in arc welding is being given free of charge by the General Electric Company at Schenectady, N. Y. A period of approximately three months is ordinarily required for a man who has had no previous experience to become a good welder. The General Electric Company awards a certificate of proficiency to those who have attained the necessary degree of skill at the completion of the course. More than 900 men have received instruction in arc welding at Schenectady, students from every state in the Union as well as from foreign countries being represented. Details of the course and a summary of the instruction given are available in a bulletin recently published.

Industrial Value Brings Change in Standards Association

A far-reaching development in industrial standardization took place on Tuesday, July 9, when control of the American Standards Association passed from the hands of scientists and engineers to a group of industrial leaders that comprises the board of directors in the reorganized association.

Interest in the practical savings resulting from standardization in industry has led such prominent executives as Matthew S. Sloan, president of the New York Edison and affiliated companies, and L. A. Downs, president of the Illinois Central Railroad, to take an active hand in directing its future. Other members of the new board of directors are as follows: Bancroft Gherardi, vice president of the American Telephone & Telegraph Company; F. E. Moskovics, president of the Improved Products Corporation; Quincy Bent, vice-president of the Bethlehem Steel Company; Howard Coonley, president of the Walworth Company; R. J. Sullivan, vice-president of the Travelers Insurance Company; C. L. Collens, president of the Reliance Electric & Engineering Company; and George K. Burgess, director of the United States Bureau of Standards.

News of Canada

Beauharnois Project Progresses—Ontario Purchases Power Interests—Gas Engines Tested at Toronto University

By Campbell Bradshaw
Toronto, Canada

BY GRANTING the Beauharnois Light, Heat & Power Company the right to begin work on a fourteen-mile canal in Quebec, linking the eastern end of Lake St. Francis with the western end of Lake St. Louis, the Dominion government has ensured the addition of 350,000 to 500,000 hp. to the existing developments of Quebec, by the end of 1932.

With Frank P. Jones, president of the Canada Cement Company, Montreal, at its head there is sound reason for the statements of officers of the corporation that before the ten 50,000-hp. generators contemplated have been installed the 500,000 hp. that will ultimately be available will have been disposed of, to say nothing of the fact that the Province of Quebec expects, on the completion of the project, to obtain an annual revenue of $550,000, while the Dominion government, in turn, will be provided with a $16,000,000 navigation canal, with annual charges close to a million dollars. The corporation has the right to divert 40,000 cu.ft. of water per second from the St. Lawrence. which will permit an initial installation, at 100 per cent load factor, of 350,000 horse power.

Beauharnois is not, of course, the only power undertaking on the Soulanges section of the river. Four other companies are operating plants there now: Cedar Rapids Power & Manufacturing Company, generating some 200,000 hp., largely for export to the United States; Canadian Light & Power, utilizing around 22,000 hp. at St. Timothee; Provincial Power Company, a subsidiary of Montreal Power, operating a 12,000-hp. plant; and the Montreal Cotton Company at Valleyfield, supplying some 10,000 hp.

That one more link in its chain of purchases has been forged, to meet the ever-growing demand for industrial power in Ontario, is evident from the announcement, July 5, of the Ontario Hydro-Electric Power Commission that the purchase of Senator M. J. O'Brien's Ottawa Valley power interests has been completed. The properties involved—for which the septuagenarian legislator, of Renfrew, Ont., is reported to have received $1,800,000, consist of four power sites, Claybank, Stewartville, Burnstown and High Falls, and operating plants at Calabogie and Galetia, presently developing 6,000 hp. —will provide in all around 100,000 horsepower.

A large number of gasoline-engine tests were made in 1928 in the thermodynamics laboratory at the University of Toronto by Prof. E. A. Allcut. The engine used was a six-cylinder Continental, taken directly from the production line without special selection.

The effect of varying mixture strength was first investigated and it was found that no appreciable power increase was obtained with mixtures richer than those chemically correct. This was not in agreement with the results obtained by Ricardo and others, and it is forming the basis of a research now being undertaken on engines supplied by several manufacturers. The maximum economy, as in previous tests, was found with a weak mixture. Different fuels were also compared at full throttle and at various speeds, and no advantage was observed when the higher-priced and treated fuels were used.

Cooling-water temperatures were varied at different speeds, and no considerable change of power or economy was obtained with outlet temperatures varying from 100 to 200 deg. F. The influence of lubricants applied to the fuels was also studied, but there was no apparent change in power or fuel consumption when they were used.

Large Passenger Liner Is Electrically Driven

With the launching of the passenger liner "Pennsylvania" at Newport News on July 10, the most extensive marine electrification program ever undertaken involving vessels for passenger service was completed. The "Pennsylvania" and its two sister ships, which have been built for the Panama Pacific Line, constitute a record in size for electric ships of this type.

The three ships are designed for turbine-electric drive and complete electric operation. They are of the twin-screw design, each propeller being driven by an 8,500-hp. motor. The electricity for driving these motors is generated on each ship by two marine-type, General Electric steam turbines, each rated 6,750 shaft hp., 2,640 r.p.m., the latter corresponding to approximately 110 r.p.m. propeller speed. Each turbine has a maximum capacity of 8,500 shaft hp., 2,880 r.p.m. (120 r.p.m. propeller speed). These turbines are each direct connected to an alternating-current generator rated 5,250 kw., 2,640 r.p.m., 3,700 volts, 3 phase, and have a maximum continuous rating of 6,600 kw., 4,000 volts. The ship's rudder is controlled by means of hydro-electric steering gear consisting of four cylinders with two double plungers, located forward of the rudder stock.

Steam for driving the turbines is furnished by eight Babcock & Wilcox water-tube boilers, with a pressure rating of 300 lb. gage and a superheat of 200 deg. F. These boilers are operated under forced draft with double-front furnaces equipped with oil burners. The exhaust steam flows to a set of four condensers. The two condensers for the main propulsion turbines are the largest ever installed on an American-built steamship.

PERSONALS

F. H. WILLCOX, vice president of the Freyn Engineering Company, of Chicago, Ill., returned July 2 from a six weeks' business trip in England, in connection with consulting work for the Ford Motor Company.

A. P. SINGER, superintendent of power of the Memphis Power & Light Company, Memphis, Tenn., has resigned. He will establish a residence in Scotland. ROBERT BRUCE, chief operating engineer who has been connected with the company since 1918, has been chosen to succeed Mr. Singer.

WILLIAM L. ABBOTT, has received an honorary degree of LL.D. from the University of Illinois for outstanding work as chief operating engineer of the Commonwealth Edison Company, Chicago. He and two other prominent Chicago men are the first to receive such an honor from this institution in seventeen years.

H. D. SAVAGE, of the Combustion Engineering Corporation, was elected president of the Stoker Manufacturers' Association at its recent annual meeting. JOSEPH G. WORKER was elected vice-president, and F. H. DANIELS, treasurer. WILLIAM V. MCALLISTER was reappointed secretary.

H. BOYD BRYDON, chief designing engineer for the H. M. Byllesby Company, of Chicago, Ill., has arrived in North Bend, Oregon, bringing plans for the improvements to the steam-electrical plant there which is to cost, when completed, a million and a quarter dollars.

O. H. ESCHOLTZ has been appointed manager of the patent department of the Westinghouse Electric & Manufacturing Company, succeeding O. S. Schairer, who resigned to accept a similar position with the Radio Corporation of America. Mr. Escholtz has been in the patent department of the Westinghouse company for the last five years. Previous to that time he did valuable work in electric arc welding. During the war he helped in designing the all-welded ship.

ARTHUR S. LEITCH, of Toronto, Ont., and R. E. JOHNSTON, of Vancouver, B. C., members of the American Society of Heating and Ventilating Engineers, attended the annual sales conference of the Nash Engineering Company at South Norwalk, Conn., the week of June 10.

J. F. DODGE, fuel-oil engineer of the Standard Oil Company of California and an authority on gas conservation, has been named professor of petroleum engineering in the College of Engineering of the University of Southern California. He will take up his duties there in September.

Coming Conventions

American Institute of Electrical Engineers. Pacific Coast Regional Meeting, Santa Monica, Calif. Sept. 3-6. F. L. Hutchinson, secretary, 33 West 39th St., New York City.

American Welding Society. Fall meeting at Cleveland, Ohio, Sept. 9-13. Secretary, M. M. Kelly, 33 West 39th St., New York City.

National Association of Power Engineers, 47th annual convention, Chattanooga, Tenn., Sept. 9-13. Fred Raven, secretary, 417 South Dearborn St., Chicago, Ill.

National Association of Practical Refrigerating Engineers. Twentieth annual convention at the William Penn Hotel, Pittsburgh, Pa., Nov. 4-7. Secretary, E. H. Fox, 5707 W. Lake St., Chicago, Ill.

National Exposition of Power and Mechanical Engineering, Grand Central Palace, New York City, Dec. 2-7. Charles F. Roth, manager, Grand Central Palace, New York City.

Universal Craftsmen Council of Engineers. Annual meeting in Detroit, Mich., Aug. 6-10, at the Book-Cadillac Hotel. Grand Secretary, T. H. Jones, 33 Linden Ave., Cherrydale, Va.

World Engineering Conference, Tokyo, Japan, October, 1929. All correspondence should be addressed to the Secretary, World Engineering Conference, Nikon, Kogyo Club, Morunouchi, Tokyo.

BUSINESS NOTES

FUSION WELDING CORPORATION, of Chicago, a subsidiary of the Chicago Steel & Wire Company, has taken over the sale of all welding rod manufactured by the parent company.

THE IRONTON FIRE BRICK COMPANY, of Ironton, Ohio, has recently elected the following officers: E. F. Myers, president and treasurer; W. P. Lewis and C. E. Bales, vice-presidents, and W. D. Lewis, secretary.

THE MAGNETIC MANUFACTURING COMPANY, of Milwaukee, Wis., has announced the appointment of Wells Fargo & Company as its exclusive representative for the Republic of Mexico. A. J. Hiern will be in charge.

THE ALLEN-BRADLEY COMPANY, of Milwaukee, Wis., has appointed F. L. Reynolds as district representative for the western Michigan territory. Mr. Reynolds will have his headquarters at 4143 Ellsworth Ave., Grand Rapids, Mich.

THE STEPHENS-ADAMSON MANUFACTURING COMPANY, of Aurora, Ill., has announced the appointment of H. W. Newton as district manager of the Birmingham, Ala., office. Mr. Newton has been a designing engineer with the Stephens-Adamson Company for several years. His office will be located at 1108 Martin Building, Birmingham.

THE GRISCOM-RUSSELL COMPANY, of New York City, has established a new sales office at the Lewis Building, Portland, Ore., to handle their evaporators, coolers, heat exchangers and other engineering products in that locality.

R. H. BEAUMONT COMPANY, Philadelphia, Pa., has announced the appointment of L. H. Moule as sales engineer connected with the Philadelphia office.

EDGAR J. KATES, consulting engineer, has moved his office to 570 Seventh Ave., New York City.

FUEL PRICES

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard...	New York.....	$2.35 @$2.40
Kanawha.....	Columbus.....	1.25 @ 1.50
Smokeless.....	Cincinnati.....	1.75 @ 2.00
Smokeless.....	Chicago.....	1.75 @ 2.25
S. E. Kentucky...	Chicago.....	1.35 @ 1.60
Steam.....	Pittsburgh.....	1.55 @ 1.65
Gas Slack.....	Pittsburgh.....	1.00 @ 1.10
Big Seam.....	Birmingham....	1.50 @ 1.75
Anthracite (Gross Tons)		
Buckwheat.....	New York.....	$2.50@$2.75
Barley.....	New York.....	1.50

FUEL OIL

New York—July 11, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.75c. per gal.; 36@40 deg., furnace, tank-car lots, 6c. per gal.

St. Louis—June 26, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.395 per bbl. or 42 gal.; 26@28 deg., $1.445 per bbl.; 28@30 deg., $1.495 per bbl.; 30@32 deg., $1.545 per bbl.; 32@36 deg., gas oil, 4.48c. per gal.; 38@40 deg., distillate, 5.23c.

Pittsburgh—July 2, f.o.b. local refinery, 30@34 deg., fuel oil, 5c. per gal.; 36@40 deg., 5.5c. per gal.

Philadelphia—July 6, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 22 deg. plus, $1.575@$1.625 per bbl.; 23@27 deg., $2.10@$2.15 per bbl.

Cincinnati—July 2, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5c. per gal.; 26@30 deg., 5.25c. per gal.; 30@32 deg., 5.5c. per gal.

Chicago—June 29, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 62.5c. per bbl.; 26@30 deg., 70c. per bbl.; 30@32 deg., 95c. per bbl.

Boston—July 8, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.45c. per gal.; 28@32 deg., 5.52c. per gal.

Dallas—July 6, f.o.b. local refinery, 26@30 deg., $1.30 per bbl. or 42 gallons.

TRADE CATALOGS

AIR COMPRESSORS — A twelve-page illustrated booklet describing the "Triple A" Centrifugal Compressor has been issued by the Allen Air Appliance Company, Inc., of 452 Lexington Ave., New York City. The outstanding characteristics of the compressor and its field of application are featured in the booklet.

REFRACTORY CEMENTS—The Refractory and Engineering Corporation, of 50 Church St., New York City, has issued a pamphlet discussing the applications of their product, especially in connection with the oil burner industry. Directions for use of the cement are included in the pamphlet.

CENTRIFUGAL PUMPS—Two booklets describing Manistee "RoTURBo" centrifugal pumps have been published by the Manistee Iron Works Company, of Manistee, Mich. Bulletin No. 105 describes the "RoTURBo" Horizontally Split Multi-Stage Type Pumps, and Bulletin No. 106 describes the Horizontally Split Volute Type Pumps. Specifications, illustrations and characteristics are included.

MOTOR STARTERS—An illustrated bulletin describing the "EC&M" Automatic Synchronous Motor Starter has been issued by the Electric Controller & Manufacturing Company, of Cleveland, Ohio. Illustrations showing these starters in use on motors in various industrial installations are a feature.

METAL HOSE—A pamphlet issued by the Atlantic Metal Hose Company, Inc., of New York City, describes the construction and lists the price of its flexible metal hose and tubing. The uses for this product are also developed in the pamphlet.

SWITCHING EQUIPMENT—Three bulletins dealing with recent developments in switching equipment have been issued by the Westinghouse Electric & Manufacturing Company, of East Pittsburgh, Pa. A four-page folder, No. 5181, gives the important advantages of steel switchboards and the distinctive features of the Westinghouse product. Folder 5179 deals with steel panels for swicthboards and includes photographs and diagrams of construction. Circular 1834 is entitled "Synchronous Visual Supervisory Control," and points out the application and system of operation of this equipment. Numerous illustrations of typical control lay-outs are included in the booklet.

ARC WELDING—Leaflets 881B and 994A, issued by the General Electric Company, of Schenectady, N. Y., detail, respectively, a gas-engine-driven arc welder that furnishes a welding current independent of local power limitations, and a travel carriage for automatic arc welders.

WATER WHEELS — Bulletin W204, just issued by The James Leffel & Company, of Springfield, Ohio, describes the installation of Leffel Water Wheels at the Hamilton, Ohio, plant of the Ford Motor Company.

New Plant Construction

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., Riverside—City plans an election to vote $690,000 bonds for the construction of a waterworks system including wells, pumping plants, etc.

Calif., Sawtelle—National Home for Disabled Veteran Soldiers, Colonel Hadley, Governor, will soon award contract for the construction of a group of buildings for soldiers home including steam heating system, etc. Estimated cost $1,000,000. Walker & Eisen, Western Pacific Bldg., are architects.

Calif., Salinas—City awarded contract for the construction of a sewage treatment plant and pumping stations to E. M. Funk, Arcadia. Estimated cost $102,900.

Conn., Bristol—New Departure Mfg. Co., 269 North Main St., awarded contract for the construction of a boiler house in connection with forge plant to include two 600 hp. Babcock & Wilcox high pressure boilers, etc. to Aberthaw Co., 80 Federal St., Boston, Mass.

Conn., Hartford—Terry Steam Turbine Co., Windsor Ave., is having plans prepared for the construction of a boiler plant. Estimated cost $40,000. Westcott & Mapes Inc., 139 Orange St., New Haven, are architects.

Conn., New Haven—Bd. of Trustees, Yale University, awarded contract for the construction of a medical and pediatrics building on Cedar St. to Sperry & Treat, 294 Timberly St. Estimated cost $1,000,000.

Fla., Miami—City will soon award contract for the construction of a sewage system including pumping station. Private plans.

Fla., Palm Beach—City awarded contract for the construction of two pumping stations in connection sewage treatment work, to Central Station Equipment Co., Seybold Bldg., Miami. Estimated cost $82,000.

Ill., Belleville—Belleville Hotel Co., 218 Commercial Bldg., awarded contract for the construction of a 7 story hotel at Public Sq. and Illinois St. to Bergmann & Lutz, 519 Scheel St. Estimated cost $600,000. G. L. Thompson Hotel Co., c/o Marquette Hotel, 18th St. and Washington Ave., St. Louis, Mo., lessee.

Ind., Fort Wayne—Lincoln National Bank & Trust Co., is receiving bids for a 28 story bank and office building. Estimated cost $5,000,000. A. M. Strauss, Fort Wayne, is architect. Walker & Weeks, 2341 Carnegie Ave., Cleveland, O., are associate architects.

Ind., Gary—Bd. of Public Works, A. Barrett, Clk., City Hall, will soon receive bids for the construction of a sewage disposal plant and pumping station. Estimated cost $2,750,000. W. P. Cottingham, City Hall, are consulting engineers.

Ind., Greenburg—Odd Fellows Home, awarded contract for the construction of an institution including power house, two 150 hp. boilers, vacuum pump, boiler feed pump, etc., to Moir & Davis, Westport. Estimated cost $150,000.

Ia., Cedar Rapids—City will receive bids until Aug. 25 for sewage treatment work to include pumping plant. Estimated cost $270,000. H. R. Green Co., Bever Bldg., is engineer.

Ia., Des Moines — F. W. & J. W. Hubbell, Army Post Rd., awarded contract for the construction of a 12 story hotel at Walnut and Fourth Sts. to H. L. Stevens Co., 30 North Michigan Ave., Chicago, Ill. Estimated cost $750,000. Tangney & McGinn Hotel Co., 207 West 5th St., Waterloo, is lessee.

Ia., Sioux City—Eppley Hotels Co., c/o E. Eppley, Omaha, Neb., plans the construction of a 12 story hotel at 5th and Pierce Sts. Estimated cost $1,350,000. A. H. Gentry, 202 Dunlap Bldg., Kansas City, Mo., is architect.

Md., Annapolis—Consolidated Gas & Electric Light & Power Co., H. A. Wagner, Lexington Bldg., Baltimore, will soon receive bids for the construction of an electric sub-station. Estimated cost $15,000. A. S. Loizeaux, Monument and Constitution Sts., Baltimore, is consulting engineer.

Mass., Boston — Owner, c/o A. P. Pearce, Jr., 15 State St., is having plans prepared for the construction of an 8 story medical office building at Bay State Rd. and Sherborn St. Estimated cost $1,000,000. Blackall, Clapp & Whittemore, 31 West St., are architects.

Mass., Dorchester (Boston P.O.)—White Cross Laundry Co., 15 Barnes St., awarded contract for the construction of a laundry and boiler house on Barnes St. to Austin Co., Jefferson Bldg. Estimated cost $40,000.

Mich., Bay City—Murray Body Corp. of America, D. Wideman Secy., 1424 Aberle St., Detroit, is having sketches made for addition to power plant at 26th and Farragut Sts. A. Kahn, Inc., 1000 Marquette Bldg., Detroit, is architect and engineer.

Mich., Detroit—Dept. of Public Works, will soon award contract for the construction of a 1 story, 200 x 1,010 ft. airport including steam heating system, boilers, etc., at Gratiot St. and French Rd. Estimated cost $1,000,000. P. A. Fellows, City Hall, is city engineer.

Mo., Webster Groves—Catholic Archdiocese of St. Louis, c/o J. J. Glennon, 4510 Lindell Blvd., St. Louis, will soon award contract for a 3 and 4 story preparatory seminary here. Estimated cost $1,250,000. H. P. Hess, 1001 Ambassador Bldg., St. Louis, is architect.

Mont., Great Falls—City plans an election to vote $750,000 to $1,000,000 for waterworks system including filtration plant, pumps, etc.

Neb., Fairbury—City plans to rebuild a light and power plant destroyed by tornado. Estimated cost $50,000.

N. J., Atlantic City—Syndicate, c/o J. Friedberg, 131 South Tennessee Ave., is having preliminary plans prepared for a 20 story, apartment hotel including steam heating system, elevators, etc. at Iowa and Pacific Sts. Estimated cost $1,000,000. W. M. Stanton, Land Title Bldg., Philadelphia, Pa., is architect.

N. J., East Orange—Oraton Realty Co., J. Krieger, St. Francis Hotel, 24 East Park St., Newark, will build a 6 story hotel including steam heating, ventilation and refrigeration systems, boilers, elevators, etc. at 499 William St. Estimated cost $500,000. Warren & Warren, 31 Clinton St., Newark, are architects. Work will be done by separate contracts.

N. J., Englewood—E. Ericson, c/o Kelly & Cowan, 921 Bergen Ave., Jersey City, Archts., will receive bids about August 15 for the construction of a 9 story hotel including steam heating, refrigeration systems, boilers, elevators, etc. on Dean St. here. Estimated cost $500,000.

N. J., Jersey City—Pennsylvania R.R., Pennsylvania Station, New York, N. Y., is having preliminary plans prepared for the construction of a warehouse and cold storage plant at Exchange and Hudson Rivers. Estimated cost $1,000,000. A. C. Watson is chief engineer.

N. J., Jersey City—P. Simeone & Co. Inc., 22 Journal Sq., Archts. and Engrs., will receive bids about Aug. 1 for the construction of a power house, boiler house and tunnel at 68-70-72 Liberty Ave. for Brunswick Laundry Co. Inc., 222 Tonnele Ave. Estimated cost $160,000.

N. J., Atlantic City—McIlvaine & Roberts, Otis Bldg., Philadelphia, Pa., Archts., will receive bids until July 23 for the construction of a 24 story hotel at Park Pl. here, for Sealands Corp., Inc., c/o architects.

N. J., Paterson—Public Service Electric & Gas Co., 80 Park Pl., Newark, awarded contract for the construction of an electric substation to include three 80,000 kva. transformer tanks, one 1,000 and one 1,500 kva. motor generator sets and Prospect and Van Houten Sts. to Public Service Production Co., 80 Park Pl., Newark. Estimated cost $700,000.

N. J., Prospect Park—Bd. of Council, Municipal Bldg., plans the construction of a waterworks system including pumping station, etc. Estimated cost $15,000. S. E. Greydamus, 121 Ellison St., Paterson, is engineer.

N. Y., Brooklyn—Brownsville and East New York Hospital, will receive bids about Aug. 1 for the construction of a boiler room and laundry at Ave. A. and Rockaway Parkway. Estimated cost $40,000. E. M. Adelsohn, 26 Court St., is architect.

N. Y., Carmel — New York State Electric Corp., 123 South Cayuga St., Ithaca, plans the construction of an electric plant here.

N. Y., New York—Brandish Johnson Estate, 50 Broadway, awarded contract for the construction of an office building at 259 West 14th St. to W. F. Kenny Co., 114 5th Ave., Estimated cost $1,000,000.

N. Y., New York—New York Steam Corp., D. C. Johnson, Pres., 280 Madison Ave., awarded contract for a 117 x 178 ft. addition to steam generating plant at Water and Pearl Sts. to George A. Fuller Co., 949 Broadway. Estimated cost $250,000.

N. Y., Yonkers—S. Steinmetz, 61 School St., awarded contract for the construction of a cold storage plant to Lynch & Larkin, 127 Downing St.

O., Canton—Onesto & Miller Co., F. Onesto, Pres., 218 Cleveland Ave., is having plans prepared for the construction of a 15 story hotel at Second St. and Cleveland Ave. Estimated cost $600,000. H. L. Stevens, 30 Michigan Ave., Chicago, Ill.

O., Cincinnati—Thomas Emery Sons Inc., 115 East 4th St., is having plans prepared for the construction of an 18 story office and theatre building at Vine and Race Sts. Estimated cost $8,000,000. Delano & Aldrick, 126 East 38th St., New York, N. Y. A. B. Liptak, 565 5th Ave., New York, N. Y., and W. W. Ashleschlager, 65 Huron Ave., Chicago, Ill. are architects.

O., Findlay—Bd .of Control, plans the construction of a water supply system to include filtration plant, pumping station, etc.

O., Toledo—Mills Rhines, Bellman & Nordhoff, Ohio Bldg., Archts., will receive bids July 28 for the construction of a 25 story bank and office building on Madison St. for Ohio Savings Bank Co., Ohio Bldg. Estimated cost $2 000,000.

Okla., Enid—Youngblood Hotel Co. awarded contract for the construction of a 14 story hotel to C. D. Bass & Son, Enid. Estimated cost $750,000.

Okla., Oklahoma City—N. E. Bowden, 1006 Braniff Bldg., is having plans prepared for the construction of a 16 story hotel on Broadway. Estimated cost $1,000,000. Layton, Hicks & Forsythe, Braniff Bldg., are architects.

Pa., Media—Delaware County, G. F. Wades, Co. Controller, will soon award contract for addition to court house including steam heating system, etc. C. W. Brazer, Crozer Bldg., Chester, is architect.

Pa., Philadelphia — Women's Hospital of Philadelphia, G. H. Earl, Chn. of Bldg. Committee, 41st and Parrish Sts., plans the construction of a hospital. Estimated cost $1,500,000. Zantzinger Borie & Medary, Otis Bldg., are architects.

Pa., Pittsburgh—City will soon receive bids for additions and alterations to Howard pumping station. Estimated cost $35,000. C. M. Reppert, City-County Bldg., is engineer.

Pa., Pittsburgh—St. Francis Sisters, 45th St., awarded contract for foundations and steel for the construction of a nurses home at 45th and Galvin Sts. Estimated cost $1,250,000.

Pa., Pittsburgh—University of Pittsburgh, Bigelow and Parkman Sts., is having plans prepared for the construction of a clinic and dispensary at 5th and Lothrop Sts. Estimated cost $950,000. E. P. Mellon, 250 Madison Ave., New York, N. Y., is architect.

Tex., Abilene — H. O. Wooten, will soon award contract for the construction of a 16 story hotel. D. S. Castle Co., Abilene, is architect.

Tex., Denton—City, will soon award contract for the construction of a 1 story, 86 x 208 ft. power house. J. R. Greenwood, 933 Allen Bldg., Dallas, is engineer.

Tex., Mercedes—R. W. Alford, 120 West Craig St., San Antonio, will soon award contract for the construction of a 50 ton ice plant here. Estimated cost $50,000.

Va., Williamsburg—William and Mary College plans addition to power plant.

Wash., Seattle — J. Vance, c/o V. W. Voorhees, Lloyd Bldg., Archt., awarded contract for the construction of a 15 story office building at Third and Union Sts. to West Coast Construction Co., Lloyd Bldg.,

Wash., Tacoma—Port of Tacoma Commission, will soon award contract for the construction of a refrigeration terminal, 1,000,000 ft. of refrigeration space with provision for handling frozen fruit and berries.

Man., Winnipeg—City awarded contract for the construction of a hydro-electric plant at Slave Falls on Winnipeg River to John Gunn & Sons, Ltd., 508 Avenue Bldg., and Stewart & Cameron Ltd, 604 West Permanent Loan Bldg. Estimated cost $8,000,000.

Ont., Harrow—City Council, is having plans prepared for the construction of a waterworks system to including electric pumping plant, etc. Estimated cost $56,000. A. W. Connor, Town Hall, Riverside, is engineer.

Ont., Port Arthur—Saskatchewan Elevators Ltd. awarded contract for the construction of a grain elevator, including elevator and conveying equipment, electrically operated. Estimated cost $1,000,000. C. D. Howe & Co., Whalen Bldg., are engineers.

Ont., Toronto—Consumers Gas Co., awarded contract for the construction of a boiler house and compressor house on Bathust St. to Wells & Gray, Confederation Bldg. Estimated cost $60,000.

Ont., Toronto—Hydro Electric Power Commission of Ontario, plans the construction of new power plants on Madawaska and Mississippi rivers in upper Ottawa Valley. F. A. Gaby, is engineer.

Ont., Toronto — Toronto Hydro Electric System, 225 Yong St., plans the construction of an electric sub-station including equipment, cables, conductors, switches, switchboards, meters, transformers, etc. on John St. Estimated cost $210,000. Private plans.

Equipment Wanted

Boiler, Pumps, etc.—Toronto Harbor Commissioners, Toronto, Ont., prices and catalogs on equipment including one oil burning Scotch type boiler, 15 ft. in diameter and 11 ft. long, fire pumps, etc. for proposed steel ice breaker and fire tug.

Engine Sets—J. C. Thomas, Crystal Springs, Miss., prices and catalogs on direct connected Corliss engine sets, one 400 hp., one 150 hp., 440 v., 3 ph. 60 cycle for proposed packing plant for Syndicate, c/o H. J. Wilson, Mgr. Estimated cost $250,000.

Generators — Bd. of Water Commissioners, W. T. Skrzycki, Pres., Detroit, Mich., will receive bids until July 31, for the installation of two 5,000 kw. steam driven turbo generators, horizontal shaft type without condensing equipment in power plant, Springwells station, Dearborn, Mich.

Pump—City of Hollis, Okla., is in the market for a 150 g.p.m. triplex pump against 160 ft. head for proposed waterworks.

Pump and Equipment—Village of Trenton, Mich., plans the installation of a vertical motor driven centrifugal pump and equipment for proposed sewage pumping station. Estimated cost $45,000.

Pumps—Village of Harmony, Minn., L. B. Miller, Recorder, will receive bids until July 29, for two motor driven pumps for proposed sewage treatment work.

Pumps—City Council, Hull, Que., is in the market for one 7,000,000 and one 9,000,000 g.p.m. pumps with motors.

Turbine, Generator and Transformers — City Council, Centralia, Wash., will receive bids until Aug. 13, for two 2,900 hp. hydraulic turbines, two 2,500 kva. electric generators, and eight 1,667 kva. transformers in connection with proposed hydro-electric plant. Estimated cost $1,000,000.

Industrial Projects

Calif., Los Angeles—PACKING PLANT and HYDROGENERATING PLANT—Cudahy Packing Co., 803 Macy St., awarded contract for the construction of a packing plant including hydro-generating building, hydrogen plant, lard refinery, etc. on Macy St. to Pozzo Construction Co., 421 Macy St. Estimated cost $70,000.

Calif., Richvale — PULP and PAPER MILL and BOILER HOUSE — Pacific Coast Pulp & Paper Co., Los Angeles, awarded contract for the construction of a pulp and paper mill including boiler room here to C. S. Mabry Co., 4th and J Sts., Sacramento. Estimated cost $400,000.

Calif., Stockton—CEMENT PLANT—Port Stockton Cement Co., San Francisco, is receiving bids for the construction of a plant here. Estimated cost $3,000,000. Roberts, Stevenson & Everett, 1101 Claus Spreckels Bldg., San Francisco, are engineers.

Ind., Indianapolis—BOX FACTORY—U. S. Fibre Box Co., will receive bids until July 20, for the construction of a factory at Martindale St. and Roosevelt Ave. Estimated cost $200,000. C. E. Bacon, Odd Fellows Bldg., is architect.

Ia., Burlington—BASKET FACTORY—Burlington Basket Co., E. A. Florang, Pres., will build a 2 story basket factory. Estimated cost $100,000. Work will be done by day labor under the supervision of F. Schroeder, of Management Service Co., 110 South Dearborn St., Chicago.

Mich., Detroit—BUTCHERS' SUPPLY FACTORY—Detroit Butcher Supply Co., 1455 Gratoit Ave., is having plans prepared for a 2 story factory on Bellevue Ave. Estimated cost $50,000. Pollmar & Ropes, Hoffman Bldg., are architects. Equipment for the manufacture of refrigerators, blocks, scales, etc. will be required.

Mich., Detroit—STEEL SASH FACTORY—Detroit Steel Products Co., 2255 East Grand Blvd., is having plans prepared for the construction of a 1 story, 200 x 700 ft. steel sash factory on Mount Elliott Ave. Estimated cost $400,000. Smith, Hinchman & Grylls, 800 Marquette Bldg., are architects.

N. J., Clifton—SILK HOSIERY MILL—Certified Hosiery Co., c/o Enbro Corp., 111 Academy St., Newark, awarded contract for a 1 story, 80 x 150 and 65 x 100 ft. mill at Allwood Section here to J. J. O'Leary, 125 Prospect St., Passaic. Estimated cost $40,000. Steam heating and ventilation systems, boilers, etc. will be installed.

N. Y., New York—SASH and DOOR FACTORY—Superior Fireproof Door & Sash Co., D. Schafer, Pres., 1811 Carter Ave., will build a factory at Bates, Poplar and Barbour Sts. Estimated cost $150,000. Work will be done by separate contracts.

N. Y., Tarrytown—AUTOMOBILE PLANT—Chevrolet Motor Co., 3044 West Grand Blvd., Detroit, Mich. is having plans prepared for the construction of an automobile plant. Estimated cost $1,500,000. A. Kahn Inc., 1000 Marquette Bldg., Detroit, Mich. is architect.

O., Akron—RUBBER FACTORY—Mohawk Rubber Co., S. S. Miller, Pres. and Gen. Mgr., is receiving bids for a 3 story, 75 x 100 ft. factory. Estimated cost $125,000. Henry & Murphy, Second National Bldg., are architects.

O., Youngstown—LAMP and RADIO NOVELTY FACTORY—Youngstown Radio Lamp & Novelty Co., plans the construction of a 1 story factory for the manufacture of lamps and radio novelties. Estimated cost $40,000. Plant will be electrically equipped.

Okla., Henryetta—GLASS FACTORY—Pittsburgh Plate Glass Co., Grant Bldg., Pittsburgh, Pa., awarded contract for the construction of a glass plant to include 40 x 300 ft. cutting sheds, 200 x 300 ft. warehouse, etc. here to W. S. Bellows Construction Co., 612 Oklahoma National Bank Bldg., Oklahoma City. Estimated cost $2,000,000.

Okla., Oklahoma City—COMPRESSES GAS PLANT—Pres-O-Lite Co., 30 East 42nd St., New York, awarded contract for the construction of a 60 x 131 ft. factory at Agnew Ave. and Frisco tracks here to C. B. Huffman, Oklahoma City. Estimated cost $125,000.

Pa., Philadelphia — SODA FOUNTAIN — I. Fischman & Son, 10th and Allegheny Sts., manufacturers of soda fountains, plans the construction of a 375 x 480 ft. factory at Erie and F. Sts. Estimated cost $1,500,000. C. E. Wunder, 1520 Locust St., is architect.

Tex., Corpus Christi—TILE PLANT—Owner, c/o P. Hemphill, c/o Portland Cement Assn., Athletic Bldg., Dallas, Tex., plans the construction of a tile plant. Estimated cost $275,000. Machinery and equipment to cost $200,000 will be required.